

ISSN 2531-2952

Volume 6, Issue 19 – July – December – 2022

# Journal Applied Computing

**ECORFAN<sup>®</sup>**

## **ECORFAN-Spain**

### **Chief Editor**

VALDIVIA - ALTAMIRANO, William  
Fernando. PhD

### **Executive Director**

RAMOS-ESCAMILLA, María. PhD

### **Editorial Director**

PERALTA-CASTRO, Enrique. MsC

### **Web Designer**

ESCAMILLA-BOUCHAN, Imelda. PhD

### **Web Diagrammed**

LUNA-SOTO, Vladimir. PhD

### **Editorial Assistant**

TREJO-RAMOS, Iván. BsC

### **Philologist**

RAMOS-ARANCIBIA, Alejandra. BsC

**Journal Applied Computing**, Volume 6, Issue 19, December - 2022, is a biannual Journal edited by ECORFAN-Spain. Matacerquillas Street 38, CP: 28411. Moralarzal-Madrid. WEB:

[http://www.ecorfan.org/spain/rj\\_arquitectura\\_dis.php](http://www.ecorfan.org/spain/rj_arquitectura_dis.php), [revista@ecorfan.org](mailto:revista@ecorfan.org). Editor in Chief: VALDIVIA - ALTAMIRANO, William Fernando. PhD. ISSN 2531-2952. Responsible for the last update of this issue ECORFAN Computer Unit. ESCAMILLA-BOUCHÁN, Imelda PhD. LUNA-SOTO, Vladimir PhD. Updated as of December 31, 2022.

The opinions expressed by the authors do not necessarily reflect the views of the publisher of the publication.

It is strictly forbidden the total or partial reproduction of the contents and images of the publication without permission from the Spanish Center for Science and Technology.

# **Journal Applied Computing**

## **Definition of the Journal**

### **Scientific Objectives**

Support the International Scientific Community in its written production of Science, Technology in Innovation in the Humanities and Behavioral Sciences Area, in the Sub-disciplines of international architecture, technological innovation in architecture, industrial design, business design techniques, multimedia design, advertising design, web system design, residential architecture.

ECORFAN-México, S.C. is a Scientific and Technological Company that contributes to the formation of Human Resources focused on continuity in the critical analysis of International Research and is attached to the RENIECYT of CONACYT with number 1702902, its commitment is to disseminate the research and contributions of the International Scientific Community, academic institutions, agencies and entities of the public and private sectors and contribute to the linking of researchers who carry out scientific activities, technological developments and training of specialized human resources with governments, companies and social organizations.

Encourage the dialogue of the International Scientific Community with other study centers in Mexico and abroad and promote a broad incorporation of academics, specialists and researchers to the Serial publication in Science Niches of Autonomous Universities - State Public Universities - Federal IES - Polytechnic Universities - Technological Universities - Federal Technological Institutes - Normal Schools - Decentralized Technological Institutes - Intercultural Universities - S&T Councils - CONACYT Research Centers.

### **Scope, Coverage and Audience**

Journal of Applied Computing is a Journal edited by ECORFAN-México, S.C. in its Holding with a repository in Spain, it is a peer-reviewed and indexed scientific publication on a quarterly basis. It supports a wide range of contents that are evaluated by academic peers by the Double-Blind method, around topics related to the theory and practice of systems theory, networks, interconnectivity of companies, corporate governance, satellite communication, connectivity, TV transmitters and transmission, microwave links, radio communications and radio receivers, radiocommunication, radio receivers, TV receivers, Telephony, Radio and TV transmitters with diverse approaches and perspectives, which contribute to the dissemination of the development of Science Technology and Innovation that allow arguments related to decision-making and influence the formulation of international policies in the Field of Engineering Sciences and Technology. The editorial horizon of ECORFAN-México® extends beyond academia and integrates other segments of research and analysis outside of that field, as long as they meet the requirements of argumentative and scientific rigor, in addition to addressing topics of general and current interest of the International Scientific Society.

## **Editorial Committee**

CENDEJAS - VALDEZ, José Luis. PhD  
Universidad Politécnica de Madrid

DE LA ROSA - VARGAS, José Ismael. PhD  
Universidad París XI

DIAZ - RAMIREZ, Arnoldo. PhD  
Universidad Politécnica de Valencia

GUZMÁN - ARENAS, Adolfo. PhD  
Institute of Technology

LARA - ROSANO, Felipe. PhD  
Universidad de Aachen

MEJÍA - FIGUEROA, Andrés. PhD  
Universidad de Sevilla

RIVAS - PEREA, Pablo. PhD  
University of Texas

RODRIGUEZ - ROBLEDO, Gricelda. PhD  
Universidad Santander

TIRADO - RAMOS, Alfredo. PhD  
University of Amsterdam

VAZQUES - NOGUERA, José. PhD  
Universidad Nacional de Asunción

## **Arbitration Committee**

ANTOLINO - HERNANDEZ, Anastacio. PhD  
Instituto Tecnológico de Morelia

CASTRO - RODRÍGUEZ, Juan Ramón. PhD  
Universidad Autónoma de Baja California

OLVERA - MEJÍA, Yair Félix. PhD  
Instituto Politécnico Nacional

HERNÁNDEZ - MORALES, Daniel Eduardo. PhD  
Centro de Investigación Científica y de Educación Superior de Ensenada

PEREZ - ORNELAS, Felicitas. PhD  
Universidad Autónoma de Baja California

HERNÁNDEZ - HERNÁNDEZ, José Luis. PhD  
Instituto Tecnológico de Chilpancingo

FLORES - FLORES, Mercedes. PhD  
Tecnológico de Estudios Superiores de Ecatepec

MAYA - PÉREZ, Petra Norma. PhD  
Universidad Tecnológica del Valle de Toluca

HERRERA, Beatriz. PhD  
Universidad Autónoma del Carmen

CASANOVA - VALENCIA, Salvador Antelmo. PhD  
Universidad Michoacana de San Nicolás de Hidalgo

GUTIERREZ - CARREON, Gustavo Alfonso. PhD  
Universidad Michoacana de San Nicolás de Hidalgo

## **Assignment of Rights**

The sending of an Article to Journal of Applied Computing emanates the commitment of the author not to submit it simultaneously to the consideration of other series publications for it must complement the Originality Format for its Article.

The authors sign the Authorization Format for their Article to be disseminated by means that ECORFAN-Mexico, S.C. In its Holding Spain considers pertinent for disclosure and diffusion of its Article its Rights of Work.

## **Declaration of Authorship**

Indicate the Name of Author and Co-authors at most in the participation of the Article and indicate in extensive the Institutional Affiliation indicating the Department.

Identify the Name of Author and Co-authors at most with the CVU Scholarship Number-PNPC or SNI-CONACYT- Indicating the Researcher Level and their Google Scholar Profile to verify their Citation Level and H index.

Identify the Name of Author and Co-authors at most in the Science and Technology Profiles widely accepted by the International Scientific Community ORC ID - Researcher ID Thomson - arXiv Author ID - PubMed Author ID - Open ID respectively.

Indicate the contact for correspondence to the Author (Mail and Telephone) and indicate the Researcher who contributes as the first Author of the Article.

## **Plagiarism Detection**

All Articles will be tested by plagiarism software PLAGSCAN if a plagiarism level is detected Positive will not be sent to arbitration and will be rescinded of the reception of the Article notifying the Authors responsible, claiming that academic plagiarism is criminalized in the Penal Code.

## **Arbitration Process**

All Articles will be evaluated by academic peers by the Double-Blind method, the Arbitration Approval is a requirement for the Editorial Board to make a final decision that will be final in all cases. MARVID® is a derivative brand of ECORFAN® specialized in providing the expert evaluators all of them with Doctorate degree and distinction of International Researchers in the respective Councils of Science and Technology the counterpart of CONACYT for the chapters of America-Europe-Asia- Africa and Oceania. The identification of the authorship should only appear on a first removable page, in order to ensure that the Arbitration process is anonymous and covers the following stages: Identification of the Journal with its author occupation rate - Identification of Authors and Coauthors - Detection of plagiarism PLAGSCAN - Review of Formats of Authorization and Originality-Allocation to the Editorial Board- Allocation of the pair of Expert Arbitrators-Notification of Arbitration -Declaration of observations to the Author-Verification of Article Modified for Editing-Publication.

## **Instructions for Scientific, Technological and Innovation Publication**

### **Knowledge Area**

The works must be unpublished and refer to issues of systems theory, networks, interconnectivity of companies, corporate governance, satellite communication, connectivity, TV transmitters and transmission, microwave links, radio communications and radio receivers, radio communication, radio receivers. radio, TV receivers, Telephony, Radio and TV transmitters and other topics related to Engineering Sciences and Technology.

## **Presentation of the Content**

*In Issue 19*, is presented an article *Development of busbar differential protection algorithm on PSCAD*, by SHIH, Meng Yen, LEZAMA-ZÁRRAGA, Francisco Román, CHAN-GONZALEZ, Jorge de Jesús and SALAZAR-UITZ, Ricardo Rubén, with adscription at Universidad Autónoma de Campeche, in the next article *WMS computer tool of the company "Comunicación Telefónica de Antequera"*, by ALTAMIRANO-CABRERA, Marisol, BENITEZ-QUECHA, Claribel, TORAL-ENRIQUEZ, Fernando and JIMENEZ-HALLA, Johann Francisco, with adscription at Instituto Tecnológico de Oaxaca, in the next section *Mobile application: social network for the search for missing persons*, by RAFAEL-PÉREZ, Eva, MARTÍNEZ-CASTELLANOS, Francisco Emmanuel, MORALES-HERNÁNDEZ, Maricela and MINGÜER-ALLEC, Luz María, with adscription at Instituto Tecnológico de Oaxaca, in the next section *Mobile application to traceability of corn production in the Valle del Mezquital*, by PEREZ-BAUTISTA, Mario, NAVARRETE-ARIAS, Dulce Jazmín and HERNANDEZ-GARCIA, Héctor Daniel, with adscription at Instituto Tecnológico Superior del Occidente del Estado de Hidalgo.

## Content

Article	Page
<b>Development of busbar differential protection algorithm on PSCAD</b> SHIH, Meng Yen, LEZAMA-ZÁRRAGA, Francisco Román, CHAN-GONZALEZ, Jorge de Jesús and SALAZAR-UITZ, Ricardo Rubén <i>Universidad Autónoma de Campeche</i>	1-7
<b>WMS computer tool of the company "Comunicación Telefónica de Antequera"</b> ALTAMIRANO-CABRERA, Marisol, BENITEZ-QUECHA, Claribel, TORAL-ENRIQUEZ, Fernando and JIMENEZ-HALLA, Johann Francisco <i>Instituto Tecnológico de Oaxaca</i>	8-14
<b>Mobile application: social network for the search for missing persons</b> RAFAEL-PÉREZ, Eva, MARTÍNEZ-CASTELLANOS, Francisco Emmanuel, MORALES-HERNÁNDEZ, Maricela and MINGÜER-ALLEC, Luz María <i>Instituto Tecnológico de Oaxaca</i>	15-22
<b>Mobile application to traceability of corn production in the Valle del Mezquital</b> PEREZ-BAUTISTA, Mario, NAVARRETE-ARIAS, Dulce Jazmín and HERNANDEZ-GARCIA, Héctor Daniel <i>Instituto Tecnológico Superior del Occidente del Estado de Hidalgo</i>	23-29



## Development of busbar differential protection algorithm on PSCAD

## Desarrollo del algoritmo de protección diferencial barras en PSCAD

SHIH, Meng Yen†\*, LEZAMA-ZÁRRAGA, Francisco Román, CHAN-GONZALEZ, Jorge de Jesús and SALAZAR-UITZ, Ricardo Rubén

*Universidad Autónoma de Campeche, Campus V, Predio s/n por Av. Humberto Lanz Cardenas y Unidad Habitacional Ecológica Ambiental, Col. Ex-Hacienda Kala, CP 24085, San Francisco de Campeche, Cam., México.*

ID 1<sup>st</sup> Author: *Meng Yen, Shih* / ORC ID: 0000-0001-7475-6458, CVU CONACYT ID: 408617

ID 1<sup>st</sup> Co-author: *Francisco Román, Lezama-Zárraga* / ORC ID: 0000-0003-3397-7881, Researcher ID Thomson: U-1229-2018, CVU CONACYT ID: 205493

ID 2<sup>nd</sup> Co-author: *Jorge de Jesus, Chan-Gonzalez* / ORC ID: 0000-0002-8638-1646

ID 3<sup>rd</sup> Co-author: *Ricardo Rubén, Salazar-Uitz* / ORC ID: 0000-0003-2307-737X, CVU CONACYT ID: 416277

DOI: 10.35429/JCA.2022.19.6.1.7

Received July 10, 2022; Accepted December 30, 2022

### Abstract

This article analyzes the behavior of the fault currents by means of a numerical differential protection algorithm developed in a simulation program called PSCAD (Power System Computer Assisted Design). The protection algorithm does the current comparison in order to obtain a graph result which indicates the state of operation. The developed algorithm also has a variable fault control panel to activate several combinations of possible fault types. This differential protection algorithm is designed to protect only the internal faults for the busbar. Finally, the results are displayed by graphs from the response of applied faults. This can be used as simulation exercises for the undergraduate engineering students to better comprehend the operation of differential protection.

**Busbar protection, Differential protection fault analysis, Internal and external faults**

### Resumen

Se analiza en este artículo el comportamiento de las corrientes de falla mediante el algoritmo de protección diferencial numérico desarrollado en el programa de simulación llamado PSCAD (Power System Computer Assisted Design). El algoritmo de protección realiza las comparaciones de las corrientes para poder obtener una gráfica de resultado que indica el estado de la operación. El algoritmo desarrollado también tiene un panel de control variable para activar distintas posibles de combinaciones de tipos de fallas. Este algoritmo está diseñado para proteger solamente las fallas internas de la barra. Finalmente, los resultados son desplegadas en forma de gráficas de acuerdo con las respuestas de las fallas aplicadas. Este puede ser utilizado como ejercicios de simulación para los estudiantes de licenciatura de ingeniería para comprender mejor la operación de la protección diferencial.

**Análisis de fallas, Protección de barra, Protección diferencial, Fallas internas y externas**

**Citation:** SHIH, Meng Yen, LEZAMA-ZÁRRAGA, Francisco Román, CHAN-GONZALEZ, Jorge de Jesús and SALAZAR-UITZ, Ricardo Rubén. Development of busbar differential protection algorithm on PSCAD. Journal Applied Computing. 2022. 6-19:1-7.

\* Correspondence from the Author (E-mail: smengyen@uacam.mx)

† Researcher contributing as first author.

## Introduction

Protection relays contribute crucial aspects in the electrical power system health, reliability, continuity, security, energy quality, and substation personnel (Blackburn & Domin 2006). The length and outdoor characteristics of power system makes it vulnerable for multiple possible fault scenarios caused by lightning, human and/or animal accidents, substation insulator contamination and weather conditions. (Blackburn & Domin 2006). Hence, protection relays in power substations should operate to isolate the faulted zone and minimize the damage impact.

The Busbar Differential Protection within a substation detects faults by comparing the sum of all currents flowing into and out of the protected Busbar. This current sum must always be equal to zero (Kirchhoff's current law) in stable conditions (IEEE/PES Power System Relaying Committee 1979). Therefore, fault conditions are the appearance of a differential current (current not equal to zero). Due to its fast-tripping characteristic it is also used for important and costly elements such as: generators (Kasztenny B. & Finney D. 2005), transformers (Saleh S. & Ozkop E. 2021), and transmission lines (Blackburn & Domin 2006). Differential protection may also be used for active distribution lines (Chen G., et al 2020).

This can be achieved by positioning a current transformer in the protected zone. It is connected directly to the busbar which is needed to be protected. The current transformer plays an important role in the protection system by transforming the primary currents to small samples of secondary currents which is then processed to enable the comparison of the restraint and tripping current by the differential relay. Hence, the differential protection is a very reliable scheme based on Kirchhoff's current law. However, current transformer saturations need to be taken into consideration as their secondary samples may no longer be trustworthy and may mislead the differential protection (Kasztenny B. & Finney D. 2005). Shortly the logical result of the comparison is then used to activate the relay to open the busbar if there is any fault is in presence.

Some busbar protections used in the history can be mentioned:

- Percentage border or low impedance current differential protection.
- High impedance differential protection.
- Linear transducer differential protection.
- Differential protection based on stabilization.
- Differential protection relay

In this work, PSCAD (Power System Computer Assisted Design) platform has been used. Other power system analysis platform such as ATP can also be used for the differential protection modelling and analysis (Tavares K. & Silva K 2014).

## Justification

A substation busbar is a thick strip of copper that conducts large amount of current. Its principal function is to supply several electrical circuits by connecting them together on the same node. Since there are many circuits that are connected on the same node, a fault located on the busbar (internal fault) can severely damage numerous circuits which can lead to possible failure of electrical components located nearby and furthermore cause significant economic loss. For that reason, the existence of "Busbar Differential Protection" is an essential component in the power system network to avoid the mentioned damages by tripping out the system when an internal fault has occurred. On the other hand, the protection should never trip out the system when there is an external fault no matter how close it is to the busbar (Elmore 2003).

The developed Busbar Differential Protection can be used as simulation exercises for the undergraduate engineering students to better comprehend the operation of differential protection when there is an internal or external fault.

## Objective

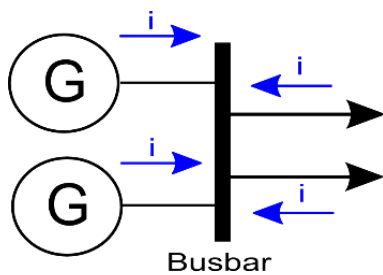
To develop an academic numerical Busbar Differential Protection on PSCAD (Power System Computer Assisted Design) and analyze the operation and behavior of this protection for the different types of faults, whether internal or external.

**Hypothesis**

The developed numerical Busbar Differential Protection on PSCAD should be sensitive enough to operate only for internal faults, in this case, faults on busbar. Whereas the algorithm should discriminate and not operate for any external faults whether they are single-phase, double-phase or even three-phase.

**Differential protection problem formulation**

The busbar differential protection works under certain conditions and characteristics of the circuit. Measurements read by the current transformer are taken from points of the protected zone which are used for conditioning. Hence, the protected zone of this configuration is the busbar that connects the generators to the transmission lines shown in Figure 1.



**Figure 1** Busbar protection scheme  
Source: Own elaboration

Current samples are then taken from the current transformer measurements for the algorithm comparison. Those sampled currents are presented in the following equations (Ziegler G. 2005):

$$I_{op_{me}} = |\bar{I}_1 + \bar{I}_2 + \bar{I}_3 \dots \bar{I}_n| \quad (1)$$

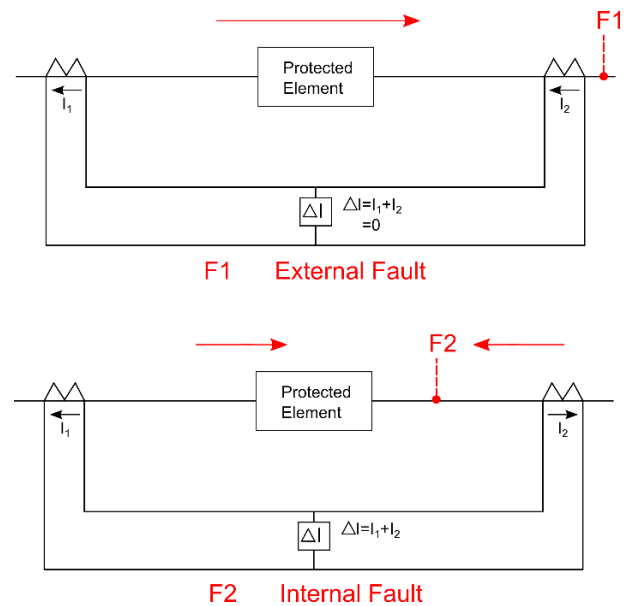
$$I_{rest} = |\bar{I}_1| + |\bar{I}_2| + |\bar{I}_3| \dots |\bar{I}_n| \quad (2)$$

$$I_{diff} = 1 A \quad (3)$$

$$I_{op_{cal}} = I_{diff} + k I_{rest} \quad (4)$$

Where  $I_{op_{me}}$  represents the measured tripping current,  $I_{rest}$  represents the restraint current,  $I_{diff}$  represents differential current,  $I_{op_{cal}}$  represents the calculated tripping current,  $k$  represents the percentage sensitivity factor of the differential protection and  $\bar{I}_1, \bar{I}_2, \bar{I}_3, \bar{I}_n$  are the currents of each phase and neutral current.

The  $I_{op_{me}}$  is the effective value (RMS) of the vector sum of all the current that goes in and out of the bus (Ziegler G. 2005). The  $I_{rest}$  is the geometric sum (magnitude) of each and every effective value that goes in and out of the bus. The  $I_{diff}$  is a programmed constant value which in the algorithm is set as 1 ampere. The  $I_{op_{cal}}$  is the sum of differential current plus the product of the restraint current multiplied by the  $k$  factor. In which the  $k$  factor is a threshold that allows the manipulation of the algorithm sensibility in an interval of 20 to 90%. The threshold  $k$  represents a slope that decreases sensibility when the  $k$  value increases. So eventually the system's protection will be delayed or even become inactive when  $k$  value increases excessively. As a result, the threshold  $k$  is set to 80% due to the system characteristics in order to respond in an accurate way.



**Figure 2** Differential protection internal and external faults  
Source: Own elaboration

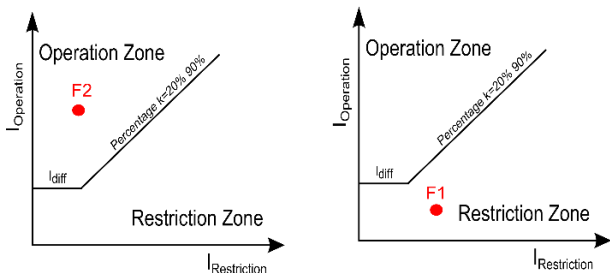
All in all, the tripping criterions of the protection algorithm are shown in Figure 2 and in the following equations:

$$I_{op_{me}} > I_{op_{cal}} \quad (5)$$

$$I_{op_{me}} < I_{op_{cal}} \quad (6)$$

Where equation 5 shows the numerical condition of internal fault (Tripping operation) and equation 6 shows the external fault condition or load (No tripping operation).

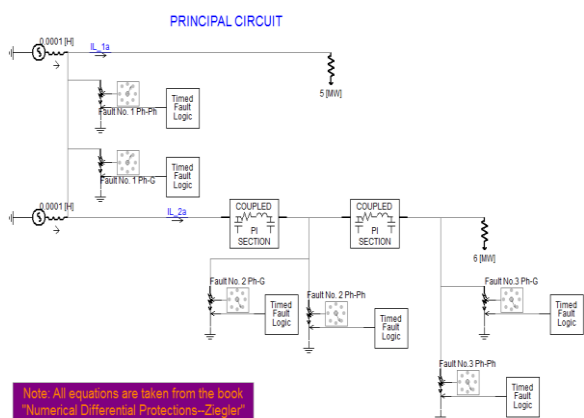
The differential protection algorithm permits the formation of tripping condition and the manipulation of the reaction velocity. This is achieved by changing the  $k$  value. Figure 3 is a graph representation of the  $k$  slope along with measured tripping current, restraint current, as well as the tripping or operation zone.



**Figure 3** Differential protection characteristics: tripping zone and restraint zone  
Source: Own elaboration

**Description of the differential protection algorithm on PSCAD**

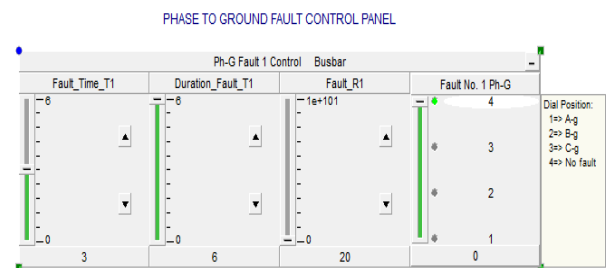
Figure 4 presents the single line diagram of the principal circuit topology for the analysis of busbar differential protection on PSCAD.



**Figure 4** Principal circuit under study in PSCAD  
Source: Own elaboration

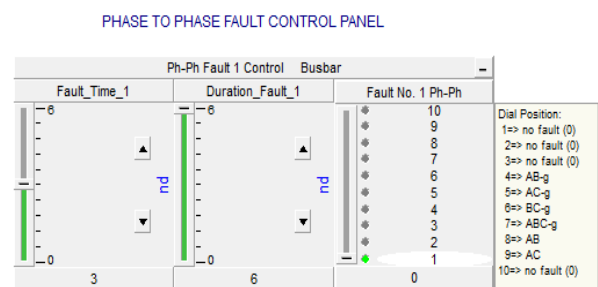
The configuration of the power system presented in Figure 4, consists of 2 generators of 10 MVA each has an internal inductance of 0.1 mH. It also has 2 transmission lines, the first is a short transmission line (less than 80 km) which is named “Transmission line 1” and has 5 MW load installed. The second is a long transmission line (more than 240 km) which is named “Transmission line 2” and has 6 MW load installed. The “Transmission line 2” is divided in two different distances. One at 250 km and the other at 300 km where the external faults are located.

The algorithm faults are divided in two classes. The first class is phase to ground faults (A-g B-g C-g). The fault control panel is possible to manage the fault occurring time, duration of the fault, phase to ground resistance, and in which phase the fault occurred. The fault control panel is presented in Figure 5.



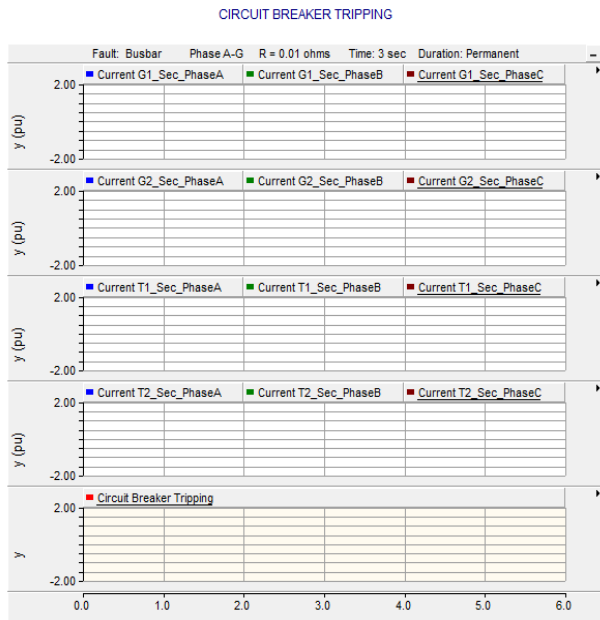
**Figure 5** Phase to ground fault control in the protected zone (busbar)  
Source: Own elaboration

The second class is phase to phase faults. (A-B A-C) and phases to ground (AB-g BC-g). This fault control panel is possible to manage the fault occurring time, duration of the fault, type of fault (which of the phases are involved) to run the simulation. The fault control panel is presented in Figure 6.



**Figure 6** Phase to phase fault control in the protected zone (busbar)  
Source: Own elaboration

All the phase to ground faults and the phase-to-phase faults are positioned on the busbar (protected zone). An external fault on Transmission line 2 at 250 km and another external fault on the same line at 300 km. Each class of fault corresponds to a fault control panel.

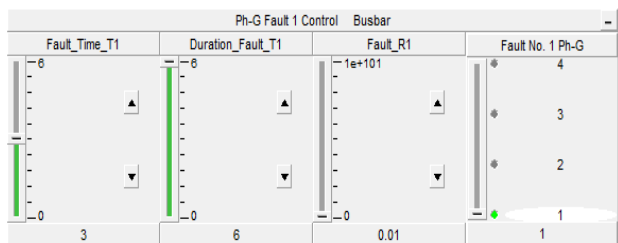


**Figure 7** (a) Generator 1 currents. (b) Generator 2 currents. (c) 5 MW load currents. (d) 6 MW load currents. (e) Display of open or closed breakers: a “0” for closed breakers and a “1” for opened breakers  
*Source: Own elaboration*

Figure 7 is a graph panel which shows all the secondary currents of the circuit. Signal “0” is used to represent “no internal fault”, in the same way a unit pulse signal “1” is used to represent “the existence of internal fault”.

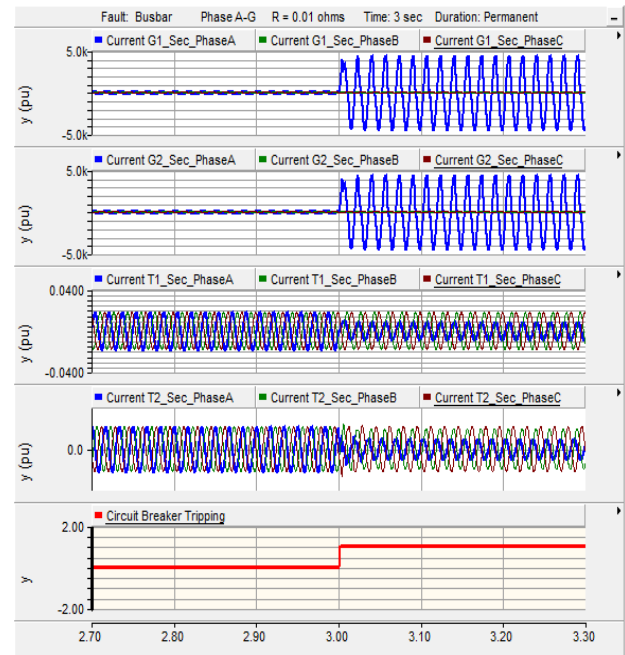
### Simulation and Results

#### Case 1.- Internal fault of phase A to ground in the principal busbar (R = 0.01 ohms).



**Figure 8** A-g fault adjustment (0.01 ohms), in the fault control panel  
*Source: Own elaboration*

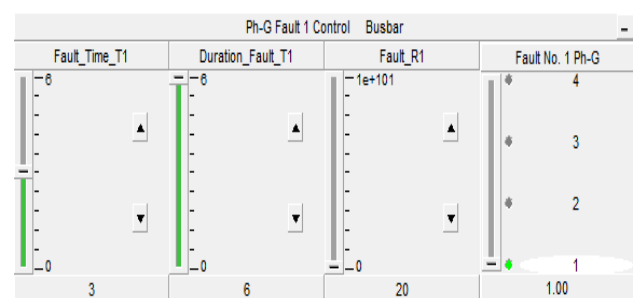
The fault occurred on the busbar within the protected zone, where phase A had contact to ground with a resistance of 0.01 ohms. The accident occurred at 3 sec during the simulation and had a permanent duration.



**Figure 9** Fault graphs (Phase A-g R = 0.01 ohms). Internal fault  
*Source: Own elaboration*

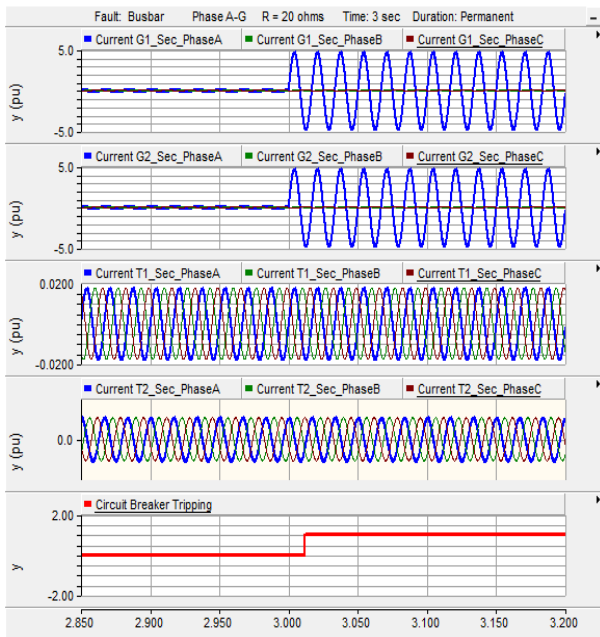
The phase A (6 MW) short circuit behavior was clearly observed in the graph. The short circuit current reaches KA levels and at the same moment the fault occurred it was observed that the graph of Figure 9 (e) had a raised unit pulse indicating the operation of the power circuit breakers. Therefore, protecting all the electrical components that are connected to the busbar in this way.

#### Case 2.- Internal fault of phase A to ground in the principal busbar (R = 20 ohms).



**Figure 10** A-g fault adjustment (20 ohms), in the fault control panel  
*Source: Own elaboration*

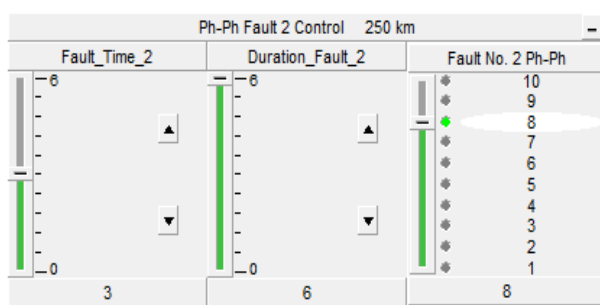
A similar situation as case 1, the phase A has a permanent fault or permanent short circuit, the only difference is that the resistance of case 1 was 0.01 ohms but now increased to 20 ohms for case 2.



**Figure 11** Fault graphs (Phase A-g R = 20 ohms). Internal fault  
Source: Own elaboration

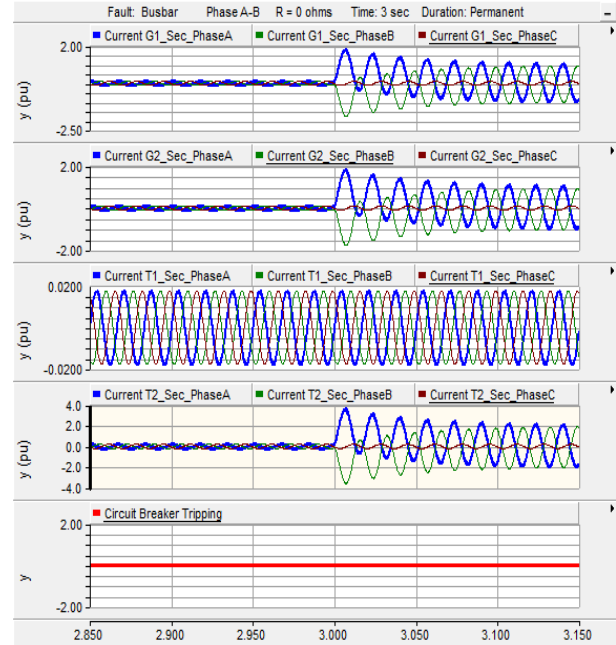
It was observed from the graph in Figure 11 that there was a fault in phase A, which was not a very elevated current in comparison to case 1. This was due to the increase of the resistance to 20 ohms. Even though the short circuit current is not very intense, there was an existence of internal fault in the protected zone, for that reason a unit pulse tripping of the power circuit breaker was shown clearly in Figure 11 (e).

**Case 3.- External fault phase A to phase B, distance 250 km.**



**Figure 12** A-B fault adjustment  
Own elaboration.

The permanent fault occurred at 3 sec during simulation and was located at 250 km from the protected zone. This is one of the most critical faults that a power system suffers, a phase-to-phase fault (A-B fault).



**Figure 13** Ph-ph fault graphs (A-B). External fault  
Source: Own elaboration

It is known that fault phase A to phase B should increase their magnitudes at the moment 3 sec of fault. Due to the distance of 250 km their magnitudes are not very elevated, but it is enough to activate the protection. The reason why the power circuit breakers did not trip was that this is an external fault. This is the correct response of the differential protection, it should only trip when there is an internal fault and under no condition should it trip for an external fault.

Differential Protection Overview Responses				
Cases	Internal Fault	External Fault	Protection Operation	Correct
F=A-g R=0.01	✓		Yes	Yes
F=A-g R=20	✓		Yes	Yes
F=A-B 250km		✓	No	Yes

**Table 1** Summary of the simulation events and responses  
Source: Own elaboration

From Table 1, it is observed that the developed busbar differential protection algorithm on PSCAD tripped for the internal faults even though fault resistance has been varied. On the other hand, the protection did not trip for the fault located at 250 km distance which corresponds to an external fault. Hence, the protection has performed correctly for the different fault events.

## Acknowledgement

The authors are grateful for the support and effort of the Universidad Autónoma de Campeche for its researchers to disseminate the research topics in which they are immersed.

## Conclusions

The busbar differential protection is an absolute protection that does not perform coordination with other protective relays. In other words, the issue with this kind of protection is not the coordination or operation sequence problem, but in fact, the ability to discriminate internal and external faults. Thus, this protection principle protects only the element within its zone and does not offer backup protection operation for other elements.

As shown in the study results in this article, the developed busbar differential protection algorithm in PSCAD has successfully discriminated the internal and external faults. Since the algorithm has operated adequately for the different faults. In addition, fault resistance was varied and did not alter the correct behavior of the algorithm.

This platform is suitable to show behavior of differential protection for the undergraduate students. Aiming that they can easily understand the basic principle of differential protection and notice the difference of external and internal faults.

## References

Blackburn J. L. & Domin T. J. (2006). *Protective relaying, principles and applications*. (3<sup>rd</sup> edition). CRC Press Taylor & Francis Group.

Chen G., Liu Y. and Yang Q. (2020). Impedance Differential Protection for Active Distribution Network, *IEEE Transactions on Power Delivery*, 35 (1), 25-36. DOI: 10.1109/TPWRD.2019.2919142

Elmore W. (2003). *Protective relaying theory and applications*. (2<sup>nd</sup> edition). CRC Press Taylor & Francis Group.

IEEE/PES Power System Relaying Committee (1979). *IEEE Guide for Protective Relay Application to Power System Buses*. ANSI/IEEE C37.97-1979. DOI: 10.1109/IEEESTD.2009.5325912

Kasztenny B. & Finney D. (2005). Generator protection and CT-saturation problems and solutions, *IEEE Transactions on Industry Applications*, 41 (6), 1452-1457. DOI: 10.1109/CPRE.2005.1430427

Saleh S. & Ozkop E. (2021). Digital Differential Protection for 3 $\phi$  Solid-State Transformers, *IEEE Transactions on Industry Applications*, 57 (4), 3474-3486. DOI: 10.1109/TIA.2021.3072877

Tavares K. & Silva K (2014). Evaluation of Power Transformer Differential Protection Using the ATP Software, *IEEE Transactions on Latin America*, 12 (2), 161-168. DOI: 10.1109/TLA.2014.6749533

Ziegler G. (2005). *Numerical Differential Protections*, Editorial Siemens

**WMS computer tool of the company "Comunicación Telefónica de Antequera"****Herramienta informática WMS de la empresa "Comunicación Telefónica de Antequera"**

ALTAMIRANO-CABRERA, Marisol†\*, BENITEZ-QUECHA, Claribel, TORAL-ENRIQUEZ, Fernando and JIMENEZ-HALLA, Johann Francisco

*Tecnológico Nacional de México – Instituto Tecnológico de Oaxaca, México.*

ID 1<sup>st</sup> Author: *Marisol, Altamirano-Cabrera* / **ORC ID:** 0000-0001-5800-9655, **CVU CONACYT ID:** 657390

ID 1<sup>st</sup> Co-author: *Claribel, Benitez-Quecha* / **ORC ID:** 0000-0001-6516-5760, **CVU CONACYT ID:** 657582

ID 2<sup>nd</sup> Co-author: *Fernando, Toral-Enriquez* / **ORC ID:** 0000-0002-5144-8839

ID 3<sup>rd</sup> Co-author: *Johann Francisco, Jimenez-Halla* / **ORC ID:** 0000-0003-4104-8126

**DOI:** 10.35429/JCA.2022.19.6.8.14

Received July 15, 2022; Accepted December 30, 2022

**Abstract**

The project presented is based on the implementation of an application for the management of the warehouse of the company Telefónica de Antequera Communication; that will allow to manage the inventory that includes: registration of entries and exits of products in a detailed manner through the PEPS method, logistics operations of suppliers and clients, the existence (stock) of articles guaranteeing the coordination of the actors of the process and the optimization of Your activities. It is integrated in this first phase in five modules: Products, Clients, Suppliers, Warehouse and Reports. The application requires a web server that will be in charge of storing the data and providing the interface within the network and the MySQL database manager. For the development, the incremental methodology was used, coding with JavaScript, with an execution environment in Node.js. PM2 was also chosen as the production process manager who will keep the services active. This application will have a positive impact on the company since it will improve warehouse operations from the purchase of the item to the final sale at the counter, including returns due to changes or damage to them. This will allow managers to make the best decisions through relevant consultations

**Application, Coordination, Existence, Logistics, Methodology**

**Resumen**

El proyecto presentado se basa en la implantación de una aplicación para la gestión del almacén de la empresa Telefónica de Antequera Comunicación; que permitirá gestionar el inventario que incluye: registro de entradas y salidas de productos de forma detallada a través del método PEPS, operaciones logísticas de proveedores y clientes, la existencia (stock) de artículos garantizando la coordinación de los actores del proceso y la optimización de sus actividades. Se integra en esta primera fase en cinco módulos: Productos, Clientes, Proveedores, Almacén e Informes. La aplicación requiere un servidor web que se encargará de almacenar los datos y proporcionar la interfaz dentro de la red y el gestor de base de datos MySQL. Para el desarrollo se utilizó la metodología incremental, codificando con JavaScript, con un entorno de ejecución en Node.js. También se eligió a PM2 como gestor del proceso de producción que mantendrá los servicios activos. Esta aplicación tendrá un impacto positivo en la empresa ya que mejorará la operativa del almacén desde la compra del artículo hasta la venta final en el mostrador, incluyendo las devoluciones por cambios o daños en los mismos. Esto permitirá a los gestores tomar las mejores decisiones mediante las consultas pertinentes

**Aplicación, Coordinación, Existencia, Logística, Metodología**

**Citation:** ALTAMIRANO-CABRERA, Marisol, BENITEZ-QUECHA, Claribel, TORAL-ENRIQUEZ, Fernando and JIMENEZ-HALLA, Johann Francisco. WMS computer tool of the company "Comunicación Telefónica de Antequera". Journal Applied Computing. 2022. 6-19:8-14.

\* Correspondence to the Author (E-mail: marisol.altamirano@itoaxaca.edu.mx)

† Researcher contributing as first author.



## Introduction

Currently, throughout the world, most SMEs must store data so that the information generated can be used by managers for good decision-making, through executive reports that support them to implement optimal strategies for the management of your business activities.

Within this management, monitoring the warehouse is one of the priorities for any businessperson if it is carried out correctly, since it allows the value chain of a product to be maintained, costs are reduced, but mainly it improves customer service.

The warehouse area of the Telefónica Communication company in Antequera is in charge of keeping track of the products that the company physically has, which are offered for sale to the public or for the telecommunications services to which the company is dedicated (television, voice and data circuit installations and maintenance). Currently, the workers in this area carry out this control based on physical records to control the inputs and outputs of products from this area.

The problems identified in this area are the following: The control of inputs and outputs of products in the warehouse, whether by purchase, sale, transfer to another branch, or required as supplies for facilities, poses a risk if they suffer damage or total loss. of the document due to mishandling or an accident at work.

Obtaining information about what products are in the warehouse takes a long time since the search must be carried out physically, this includes what refers to the quantity (maximum and minimum stock) that could stop a sale due to lack of the product or knowing products have little stock in order to program the necessary purchases.

That is why, once the necessary requirements have been surveyed, such as the type of warehouse, classification techniques, inventory systems and their management indicators; It has been proposed as a general objective to develop an application for the management of inputs, outputs and stocks in the warehouse area (WMS) of the company Comunicación Telefónica de Antequera.

Respecting, at the request of managers, that the method for classifying inventories will continue to be ABC, since they are familiar with ordering their products through generated rotation and the benefits provided (A: Greater importance, B: Importance and Moderate Rotation and C: Low Rotation ).

The document that is presented is organized by integrating: the theoretical foundation and the activities carried out during the phases defined by the incremental software development methodology, based on the philosophy of building by increasing the functionalities of the program by applying linear sequences in a staggered manner as time progresses. in the calendar, result in several sequences that produce an increment of the software in a linear way.

Subsequently, the tools used in the development are evaluated and the data modeling is created in each of the phases, with their respective user stories and a MySQL GNU GP license as a database manager.

Finally, the results obtained are shown, through the interfaces, system tests, the conclusions obtained with the implementation of the system and the impact on the automated processes that contribute to the scope of the general objective when developing a management system entitled: WMS computer tool of the company "Comunicación Telefónica de Antequera", and the thanks given to the National Technological Institute of Mexico, the Technological Institute of Oaxaca and finally, the references consulted in the preparation of the following article.

## Statement of the problem

Communication Telefónica de Antequera is a 100% Oaxacan company dedicated to the field of Telecommunications and consolidated as leaders in the integration of alarm systems, radio communication, telephony, CCTV, access control and networks; in the state of Oaxaca and southeast of the Mexican Republic.

Due to its expansion, it currently presents a logistics problem in its warehouse and therefore in the management of its inventory, which causes a detrimental financial impact on the organization since it delays the shipment of products to the customer, or the product must be denied to the customer. not being able to verify stocks or on the contrary, having a large inventory of a product can be damaged over time and not be able to make the guarantees valid, among others, which is always reflected in losses for the company

## Development

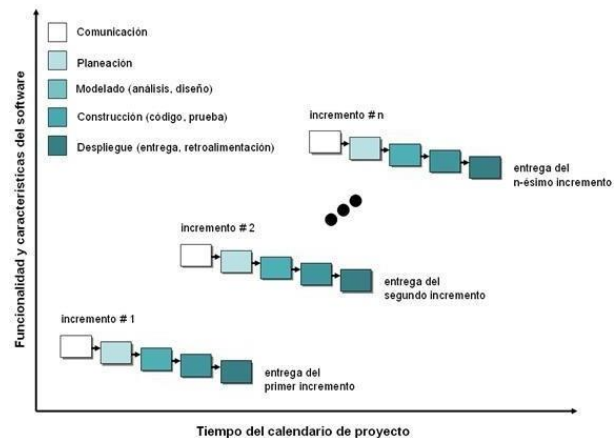
The WMS computer tool of the company "Comunicación Telefónica de Antequera" aims to solve the problems identified in the company's warehouse area as follows: Inputs and outputs will be recorded digitally in a database, which will reduce creation time and provide greater security in their consultation and updating.

Access to stock data with the application will be almost instantaneous, the same with the historical record of entry and exit transactions, being able to differentiate the entire process of entries (purchases and guarantees) and exits (sales, installations or transfers). The application will be able to warn the user about products with few stocks, which will help in making decisions for the purchase of products.

The inventory will be separated by areas, offering the above functions with equality for both areas, preserving the way of working that the company manages. For the articles, a random key (SKU) will be generated, taking into account the type of product, brand, model, purchase date, date of entry into the warehouse and the shelf in which it is located.

## Methodology

For this project, the incremental model was chosen under the Scrum methodology, which, as explained by Pressman (2002), combines elements of the waterfall model with the construction of prototypes. This methodology is based on the philosophy of building by increasing the functionalities of the program by applying linear sequences in a staggered manner as time progresses on the calendar. Figure 1 shows the incremental methodology process in which operational software is generated quickly and in early stages of the software life cycle.



**Figure 1** Life cycle by iterations

Source: Pressman, R.S. (2002). *Software Engineering: A Practical Approach*

For this project, the incremental model is used, whose stages in each increment are:

- **Communication:** Start of the project, the collection of information with the client is carried out.
- **Planning:** Estimation of resources and times, the requirements obtained are interpreted and validated.
- **Modeling:** The structure required for the increment is determined.
- **Construction:** Code development and testing.
- **Deployment:** Delivery of the product and recommendations for its operation. In addition, an initial planning is carried out, known as zero increment, to define the work plan and the characteristics of the project.

**Zero increment:** In this increment, the initial requirements gathering is performed. The planning of the activities and the increments destined to build the functionalities of the application. The technologies to be used are defined in common agreement with the directors of the company, taking into account time and experience in the development of applications, the following technologies are proposed:

Backend: Express.js and Node.js

Frontend: React.js and Node.js

Database: MySQL.

The general design of the application structure, such as user stories, is also carried out. Table 1 shows the master list of user stories grouped by category and broken down into each increment according to the increment plan shown in Table 2.

Master user history list	
1	User Management
2	Product Management
3	Inventory Management
4	Customer/Supplier Management
5	Backup of records
6	Reporting

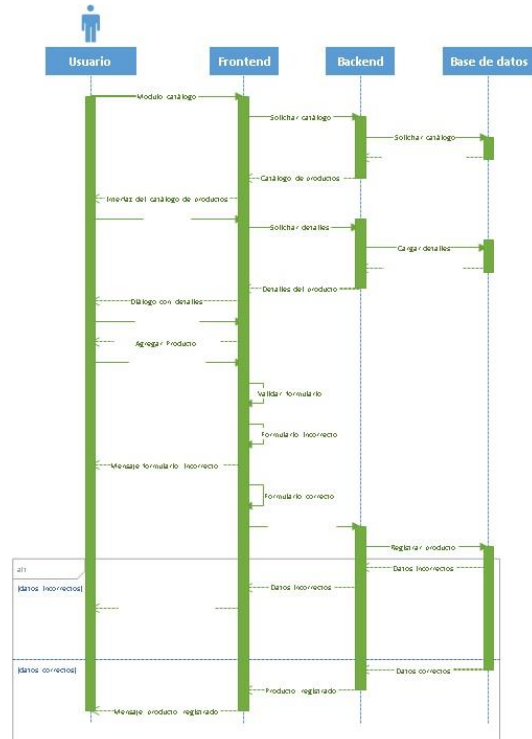
**Table 1** Master user story list  
 Source: Own elaboration

Incremental plan			
1 <sup>st</sup> Increment		2 <sup>nd</sup> Increment	3 <sup>rd</sup> increment
Display login screen	login	Product Management	Generation of system reports and scheduled backup of information.
Display user profile	user	Inventory Management	
Product registration			

**Table 2** Plan of increments  
 Source: Own elaboration

As indicated in the previous figure, three increments were programmed, of which only the most relevant of each of them will be indicated in this document.

**One increment:** Once the increment plan was designed, the sequence diagrams were defined that describe the activities that the user will carry out in the application, which are: Access Module, User Registration Module and Warehouse Product Registration Module as shown in Figure 2, which depicts the activity of querying and adding products.



**Figure 2** Inquiries and add products  
 Source: Own elaboration

The corresponding interfaces were modeled on increment one, as shown in figures 3 and 4.



**Figure 3** Edit user profile  
 Source: Own elaboration

ID	Nombre	Modelo	Categoría	Descripción	Acciones
ALABET0001	Detector inalámbrico de Rotura de Cristal / 3 en 1 / Soporta 2 Zonas Cableadas	HIBVISION DS-PD369-652-WB	Alarmas	Detector de rotura de vidrio inalámbrico con vidre...	
ALABET0001	Kit Inalámbrico de 7 Contactos 5816 y 3 Sensores de Movimiento 8209PB	HONEYWELL 5816 KIT	Alarmas	- 7 contactos magnéticos 5816 - 3 Sensores de movim...	
ENENCO0001	Modulo Solar ET-SOLAR, 450W, 50 Voc, Monocristalino, 144 Celdas grado A	ET-SOLAR ET1M57284450W/W/WB	Energía Solar	Los módulos Solares de ET-SOLAR, se encuentran...	
WATCO0001	Balboa de Cable Bineleto F/U/TP de 4 Pines, 2 MAX, CARA Volante	SEKON SAGL-A5	Materiales	El Cable F/U/TP Categoría 6A de Simon posee un re...	
RAOWEN0001	Kenwood Analógico	KENWOOD TK3320HK	Radio comunicación	45 WATTS, UHF 450-430 MHz, 16 canales	
RADRAD0001	Radio 800/900 MHz, 200 Canales, NXDN, DMR-Analógico, GPS, Bluetooth, IP67, 2 Fieles	KENWOOD NX-3420-K3	Radio comunicación	Operación del equipo con encendido por voz, I...	
RADRAD0002	Radio 450-520 MHz, DMR-Analógico, 5 Watts, 300 Canales, Bluetooth, IP67, 2 Fieles	KENWOOD NX-1300-EX3	Radio comunicación	Opera protocolo digital NXDN™ o DMR. Modo memoria...	

**Figure 4** Product catalog  
Source: Own elaboration

In the field of validations and tests, the following were carried out: Registration, Duplication, Edition, Products.

**Two increment:** Dedicated exclusively to inventory management, the A, B, C method of inventory classification was implemented in it, according to the priorities of the managers; Its interfaces are adjusted to the registration of inputs and outputs of products corresponding to acquisitions, prioritizing that the user can register input orders of the return, guarantee or surplus type with different products as long as they are associated with an output folio, indicating the details corresponding to the entry, as well as the serial numbers of the products that are re-entered. As shown in the following figure:

**Figure 5** Entry and re-entry of products  
Source: Own elaboration

Finally, in this increase, when managing the number of items and to meet the requirements of calculating the minimum quantities of a product, the safety stock formula indicated by Robinson (2020) is used:

Standard deviation of demand \* root of average lead time.

To calculate the standard deviation of demand, you must first calculate the average demand, which is the total monthly demand / number of months. Also considered in this increment is the scheduled task on the Backend server to calculate low stocks, reviewing all output records to calculate the supply time.

**Three increment:** The user will be able to generate reports of inputs, outputs, and inventory management, organizing it by established time ranges, brand, model, priorities and warehouses among many options or filters, in order to provide a better perspective in decision making by managers. The interface designed for this purpose is shown in Figure 6.

**Figure 6** Report generation  
Source: Own elaboration

For security and contingency reasons, a restoration module was developed, which works once a database backup has been made. it is recommended to do it daily and the last saved version can be restored. See figure 7.

**Figure 7** Database restore  
Source: Own elaboration

**Results**

The results obtained from the inventory system for the company Comunicación Telefónica de Antequera are presented:

- Contribution to the work methodology implemented in the company, which did not include suppliers or customers.
- To meet the needs of managers and at their suggestion, the system integrated methods considered efficient. Such is the case with the A, B, C method of product inventory.
- According to the methodology used, at the end of each increment, the product was delivered for evaluation so that the client could guarantee its functionality (using it) once configured and validated.
- The inventory system for the Telefónica Communication company in Antequera. It has the requested modules, as well as the incorporation of established business rules, in friendly and intuitive interfaces.
- The system and its structure respond to a strategy that seeks to facilitate the activities of employees in the company, streamlining the internal processes of inventory management.

**Gratitude**

We thank the Instituto Tecnológico Nacional de México/Oaxaca Technological Institute for the facilities granted to carry out the project, mainly ROGELIO ERICEL ZARATE MENDEZ, student of the Computer Systems Engineering educational program, with his experience and time in carrying out the project in the course of your professional residency.

**Conclusions**

In conclusion and based on the information collected through the various interactions with the personnel designated by the company Comunicación Telefónica de Antequera. It was possible to identify the needs, as well as the strategies that would be necessary to be able to develop a solution that complies with the necessary standards to be considered optimal, safe and stable.

Before starting with the automation, consequences of poor warehouse management were detected, which in turn represent risks for the company, which are:

- Physical or virtual losses of the material.
- Risk of impact on customer deliveries.
- Incorrect material purchase planning due to inventory discrepancies.
- Affectation in the main indicators of the company.

Investigating and discovering new knowledge and techniques allowed us to achieve the planned objectives in a timely manner, always hand in hand with the directors who were true guides, people experienced in the organization's storage and distribution management and whose aspects had the greatest impact on the development of experience is reflected in the visible decrease in the financial costs of excess inventory.

From the above, it is concluded that it is recommended that all small, medium or large companies implement an inventory management system that can be custom or commercial. Because you will realize the great benefit, investing your time in other matters of the company or your personal life.

**III. References**

- I. Absalón, R., Rivas, M., & Cornejo, A. (s/f). Construcción de bases de datos. Módulo Profesional. Cuadernillo de ejercicios para trabajo en casa. Consultado de <https://www.conalepveracruz.edu.mx/iniciobackup/wp-content/uploads/2021/03/Construcci%C3%B3n-de-bases-de-datos-M%C3%93DULO-PROFESIONAL.pdf>. En marzo de 2021.
- II. Carranza Guerrero, L. P. (2016). Gestión en Proyectos de Software. Tecnología Investigación y Academia, 4(2), 12–19. Consultado de <https://revistas.udistrital.edu.co/index.php/tia/article/view/7609>. En enero de 2021.

Codecademy Team. (2021). What is a framework? Consultado de <https://www.codecademy.com/resources/blog/what-is-a-framework/>. En Marzo de 2022.

Cohn, M. (2004). *User Stories Applied for Agile Software Development*. Boston: Pearson Education, Inc. ISBN 978-0321205681

Meta Platforms, Inc(Facebook open source) (2021). React - Una biblioteca de JavaScript para construir interfaces de usuario. Tutorial en línea. Consultado de <https://es.reactjs.org/>. En agosto 2021

García, L. A. (enero de 2016). Gestión de proyectos según el PMI. Consultado en <https://docplayer.es/23223685-Gestion-de-proyectos-segun-el-pmi.html>. Agosto 2021. licencia de Reconocimiento-NoComercial-SinObraDerivada 3.0 España de Creative Commons

Heagney, J. (2016). *Fundamentals of Project Management* (5th ed.). AMACOM Division of American Management Association International. <http://www.jstor.org/stable/j.ctt1d2dpw4>

MDN Contributors. (2021). *Aplicaciones Web Progresivas*. Obtenido de MDN: [https://developer.mozilla.org/es/docs/Web/Progressive\\_web\\_apps](https://developer.mozilla.org/es/docs/Web/Progressive_web_apps)

MDN contributors. (2021). *Javascript*. Obtenido de MDN: <https://developer.mozilla.org/es/docs/Web/JavaScript>

Menzinsky, A., Gertrudis, L., & Palacio, J. (2018). *Historias de usuario. Ingeniería de requisitos ágil*. Consultado de Scrum Manager: [https://scrummanager.net/files/historias\\_usuario\\_scrum\\_manager.pdf](https://scrummanager.net/files/historias_usuario_scrum_manager.pdf). Octubre 2021. Licencia Creative Commons Attribution 4.0

Moya, A. C. (2017). *Metodologías de gestión de proyectos*. Consultado de <https://docplayer.es/69263417-3-metodologias-de-gestion-de-proyectos.html>. Noviembre 2021

Pressman, R. S. (2010). *Ingeniería del software: Un enfoque práctico* (7ed.). McGraw Hill. ISBN:9786071503145. Consultado de <http://cotana.informatica.edu.bo/downloads/Id-Ingenieria.de.software.enfoque.practico.7ed.Pressman.PDF>.

Robinson, D. (2020). *How to Use The Safety Stock Formula: A Step- By-Step Guide*. Consultado de SkuVault: <https://www.skuvault.com/blog/safety-stock-formula/>. Septiembre 2021.

Silberschatz, A., F. Korth, H., & Sudarshan, S. (2002). *Fundamentos de bases de datos*. Cuarta edición. Madrid: McGraw Hill. ISBN: 84-481-3654-3 Consultado de [http://mirrors.sandino.net/pelogo/FundaBD/FundaBD\\_Silberschatz.pdf](http://mirrors.sandino.net/pelogo/FundaBD/FundaBD_Silberschatz.pdf).

Sommerville, I. (2011). *Software engineering* 9th Edition. Addison Wesley. ISBN-13: 978-0-13-703515-1 Consultado de <https://engineering.futureuniversity.com/BOOKS%20FOR%20IT/Software-Engineering-9th-Edition-by-Ian-Sommerville.pdf>.

**Mobile application: social network for the search for missing persons****Aplicación móvil: red social para la búsqueda de personas desaparecidas**

RAFAEL-PÉREZ, Eva†\*, MARTÍNEZ-CASTELLANOS, Francisco Emmanuel, MORALES-HERNÁNDEZ, Maricela and MINGÜER-ALLEC, Luz María

*Tecnológico Nacional de México, Instituto Tecnológico de Oaxaca, Departamento de Sistemas y Computación. Avenida Ing. Víctor Bravo Ahuja No. 125 Esquina Calzada Tecnológico, Oaxaca, Oax., México.*

ID 1<sup>st</sup> Author: *Eva, Rafael-Pérez* / **ORC ID:** 0000-0003-2793-1254, **CVU CONACYT ID:** 905268

ID 1<sup>st</sup> Co-author: *Francisco Emmanuel, Martínez-Castellanos* / **ORC ID:** 0000-0003-0759-6495, **CVU CONACYT ID:** 1244671

ID 2<sup>nd</sup> Co-author: *Maricela, Morales-Hernández* / **ORC ID:** 0000-0002-3521-2041, **CVU CONACYT ID:** 731036

ID 3<sup>rd</sup> Co-author: *Luz María, Mingüer-Allec* / **ORC ID:** 0000-0003-2954-1815, **CVU CONACYT ID:** 786966

**DOI:** 10.35429/JCA.2022.19.6.15.22

Received July 25, 2022; Accepted December 30, 2022

**Abstract**

Today, mobile applications have become more relevant than ever, they have changed the way of life of people in all sectors of society. The mobile application: Social network for the search for missing persons, is an application under Android developed with the aim of helping to find missing persons through the format of a social network. Mexico is going through a security crisis that has not only been defined by violence, homicides, kidnappings, extortion or robberies, but also by the high rates of missing or unidentified people that have impacted our daily lives. The mobile application aims to give a space to the publications of missing persons, prevention of cybercrime, streamline the process of publishing unofficial alerts and create a community under the format of a social network to share information with users that helps find missing persons. The development methodology for this application was the incremental model using the Dart programming language.

**Resumen**

En la actualidad, las aplicaciones móviles se han vuelto más relevantes que nunca, han cambiado la forma de vida de las personas en todos los sectores de la sociedad. La aplicación móvil: Red social para la búsqueda de personas desaparecidas, es una aplicación bajo Android desarrollada con el objetivo de ayudar a encontrar personas desaparecidas mediante el formato de una red social. México atraviesa una crisis de seguridad que no solo ha sido definido por la violencia, homicidios, secuestros, extorsiones o robos, sino también por los índices elevados de personas desaparecidas o no identificadas que han impactado en nuestra vida cotidiana. La aplicación móvil tiene como objetivo, dar un espacio a las publicaciones de personas desaparecidas, prevención de delitos cibernéticos, agilizar el proceso de publicación de alertas no oficiales y crear una comunidad bajo el formato de una red social para compartir información con los usuarios que ayude a encontrar a las personas desaparecidas. La metodología de desarrollo para esta aplicación fue el modelo incremental mediante el lenguaje de programación en Dart

**Mobile application, Missing persons, social network**

**Aplicación móvil, Personas desaparecidas, Red social**

**Citation:** RAFAEL-PÉREZ, Eva, MARTÍNEZ-CASTELLANOS, Francisco Emmanuel, MORALES-HERNÁNDEZ, Maricela and MINGÜER-ALLEC, Luz María. Mobile application: social network for the search for missing persons. Journal Applied Computing, 2022. 6-19:15-22.

\* Correspondence to the Author (E-mail: evarafaelperez@gmail.com)

† Researcher contributing as first author.

## Introduction

In these modern times, with the advancement of technologies, society is increasingly facing a more open environment, with greater communication benefits. Mobile applications have become indispensable technological tools to carry out our daily activities, to entertain us, to communicate and to keep us informed of what is happening or happening in our society. Mobile applications aim to make information available at all times and provide quick access to different functions, tools and online services from the palm of the hand.

UNESCO (2014) stresses that technological tools favour accessibility, autonomy, participation, communication, information, mobility and adaptation to the environment, which through their implementation allows the user to obtain information and stay connected and updated from anywhere with an Internet connection.

The development of the mobile application: Social network for the search of missing persons under the Android operating system allows the following benefits: Shortening the waiting time to be able to spread the word that a person has disappeared, that users of the community can upload alerts in the form of publication by filling in fields such as general data, last location, photograph; avoiding cybercrime, by creating the community under the format of a social network allows to disseminate and give relevance to the issue of missing persons to be helped and to help other people. It has the following modules: creation and authentication of users, creation of missing persons alerts, comments and reactions module, search and tracking between user accounts, user profile, notifications, prevention against cybercrime, filter against hurtful phrases in comments and disable screenshots.

The present work is oriented in the area of computer science in the part of software development, which describes the problem statement, software methodology, project development, results, conclusions, acknowledgements and references.

## Problem statement

Nowadays, the practice of the disappearance of people continues not only in Mexico but also worldwide. In Mexico, in recent years, the phenomenon of the disappearance of persons has become part of the severe problems of insecurity and violence that the country is experiencing.

The Law of the National Registry of Missing or Disappeared Persons, published in the Official Journal of the Federation (2012), in its article 3, section IV, establishes the concept of a missing person as:

Any person who, based on reliable information from relatives, close or related persons, has been reported missing in accordance with domestic law, which may be related to an international or non-international armed conflict, a situation of internal violence or unrest, a natural disaster or any situation that may require the intervention of a competent public authority.

For Hernández (2020), the disappearance of persons has various causes, which can be accidental, self-willed, by the will of a private individual or by the force and will of the State. In Mexico, the states of Jalisco, Tamaulipas, State of Mexico, Veracruz and Nuevo Leon, are the ones that concentrate 70.7% of disappeared and missing persons, (ADN Político, 2021), real figures that represent the missing persons in our country.

One of the problems that arise are the scarce results obtained by the institutions of justice in relation to the search and location of missing persons, since the waiting time given by the authorities to raise an official missing person alert is 48 to 72 hours, which is vital for the life of a person.

Another problem is that when a person goes missing, they use social networks such as Facebook to make a publication, and add the personal phone number to receive reports about the missing person, this generates situations of extortion by other ill-intentioned users, since exposing the personal number usually ends in telephone extortion, scams or hacking of WhatsApp or Telegram accounts.

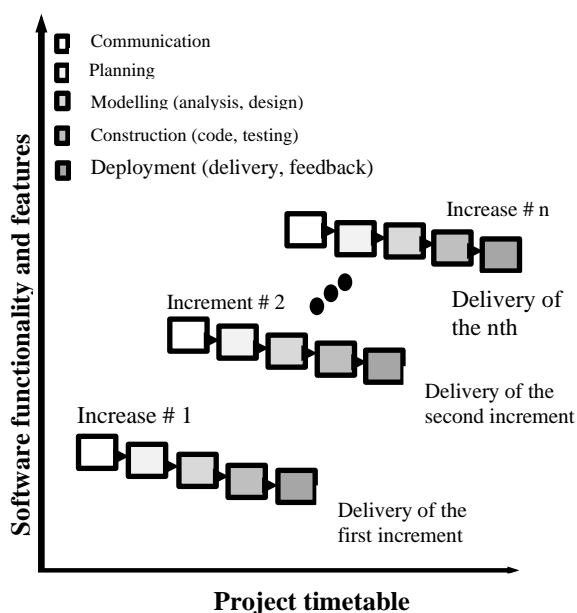


Another disadvantage is that when users or family members upload disappearing posts on social networks, their personal information such as photos and other contacts on their profile are exposed, which can also lead to identity theft. Current social networks are not designed for altruistic purposes, and at the time of creating or uploading a publication of this nature, users ignore it to see another publication focused on entertainment and fun or simply disinterest in helping.

Faced with this scenario, the mobile application is created: Social network for the search of missing persons to help people get back to their families.

### Software methodology

The incremental development model was used for this project. In the words of Pressman (2010), the model, "combines elements of the waterfall model with the interactive philosophy of prototyping. This model applies linear sequences in a staggered fashion as time progresses on the schedule. Each linear sequence produces a software increment". Its stages are: Communication, Planning, Modelling, Building and Deployment, as shown in Figure 1.



**Figure 1** Stages of the Incremental Model

Source: Pressman, R. (2010). *Software Engineering a Practical Approach*. Seventh edition

### Project development

For the development of the mobile application: Social network for the search of missing persons, aspects of versatility, ease of use and user-friendly interfaces were taken into account, which allowed to work in a more practical way and move more quickly with the project, its development was based on six increments.

In this project, six functional increments were carried out and each one of them was reviewed. The interfaces of the mobile application modules are explained in the results section. For the purposes of this article, the activities of each phase of the incremental model are described.

- Communication phase, in this activity, communication and meetings with the client were essential to identify the requirements. For the definition of functional and non-functional requirements, the user story technique, the Class-Responsibility-Collaboration-Cards (CRC) and the survey data collection technique were used.

For Cohn (2004), a user story is, "a brief description of a software functionality as perceived by the user", it is important to mention that different stories were made based on the user's needs. For Ambler (1995) the use of cards (CRC) "is a set of standard index cards that represent classes and is divided into three areas: class name, responsibilities and contributors". Hernández, Fernández and Baptista (2006, p.310) define the survey as "the instrument most commonly used to collect data, consisting of a set of questions regarding one or more variables to be measured". The survey was conducted remotely using the Google form, due to the pandemic situation and to be able to reach more people. The survey was applied to 50 people between 18 and 58 years of age, in order to identify the needs and requirements as each increment evolves for the development of the mobile application modules.

- Planning phase, in this phase the schedule of activities was created, where the activities such as the number of increments, the tasks of each of the phases of each increment, the periods of completion and delivery dates were established. The various technologies to be used in the modelling phase were also chosen. In the case of the database, it was decided to use a non-relational database. A non-relational database is one that does not use the tabular schema of rows and columns, instead it uses a storage model that is optimised for the specific requirements of the type of data being stored (Zoiner, 2018).
- Modelling phase, in this phase the different tools that were chosen in the planning stage were applied, for the design of the flowcharts and cases the tool diagrams.net was used, which is a free and open source web application that allows creating diagrams from any web browser. For the operation of the non-relational database, the Firebase Storage manager was used for the storage of images and as a database where documents, information and data are stored.
- Construction phase. In this phase the graphical user interfaces were designed in a responsive way, and the coding of the respective modules was also carried out in each of the increments, taking as a reference the delivery dates specified in the schedule of activities. For the coding of each of the modules, the open source Flutter framework developed by Google was used to create native applications in an easy, quick and simple way, using the object-oriented Dart programming language. The coding order was according to the modules developed for each increment:
  - Creation of interfaces/Navigation of interfaces.
  - Connection to the Firebase database.
  - User creation and authentication.
  - User search.
  - Creation of alerts.

- Follow/Unfollow users.
- React/Don't react alerts.
- Feedback.
- Notifications.

In this stage the tests of each module were also carried out, in this case the acceptance tests were applied. An acceptance test is defined as the testing of software by the user or client to determine whether it is accepted or not, its objective is to validate the software against the user's functional and non-functional requirements. Also at this stage, compatibility tests were carried out, verifying that the mobile application works on different mobile devices with different features under the Android 5.0 operating system or higher.

- Deployment phase: In this last phase, each of the developed modules was delivered and evaluated by the end user, in this part the necessary observations, suggestions or feedback were made depending on the module. In case of feedback, they are considered as part of the user's needs or requirements and are taken into account in the planning phase in the next increment.

## Results

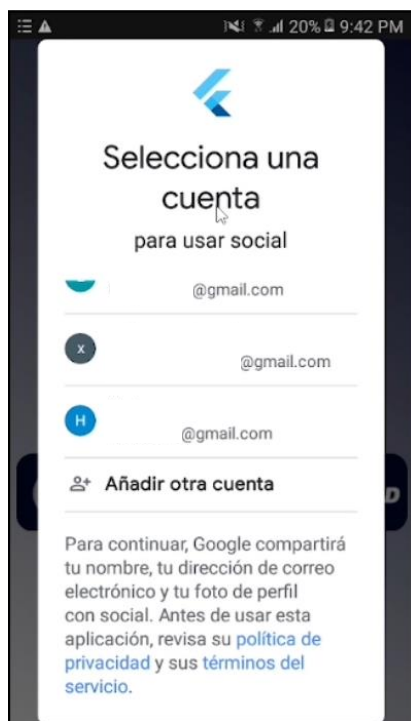
As a result of the mobile application is the development of each of the modules that were designed, coded and tested for proper functioning. The main modules of the mobile application are described below:

1. When running the mobile application it displays a welcome screen See Figure 2.



**Figure 2** Application welcome screen

- When clicking on the Join the community button, a menu is displayed where the user's Gmail email accounts that are synchronised with the mobile device are loaded. If the user does not have a Gmail account, click on the option Add another account. The user can create or add an existing account that is not on the mobile device, see figure 3.



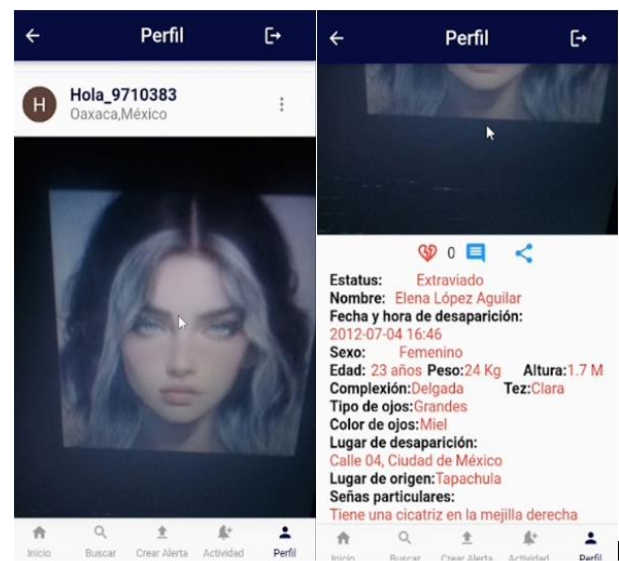
**Figure 3** Login, create or add email accounts screen

- Own profile: This is the personal profile where you can see the alerts you have published, as well as a profile photo, user name, description, a configuration button that allows you to edit or change the profile description and a logout button, as shown in figure 4.



**Figure 4** User profile screen

- Alert display: this screen shows a published alert, with the following data: the name of the user who published the alert, the place where the alert was issued, the image of the missing person, the buttons with options to react, comment and share, and the data of the missing person. See figure 5.



**Figure 5** Alert display

5. Comments: This is the interface where an alert can be commented. On the right-hand side you can see what a censored comment looks like.



Figure 6 Comments screen

6. Search user: This interface shows how to enter the name of a user to be searched, once the name appears, click on it and it sends us directly to the profile. See figure 7.

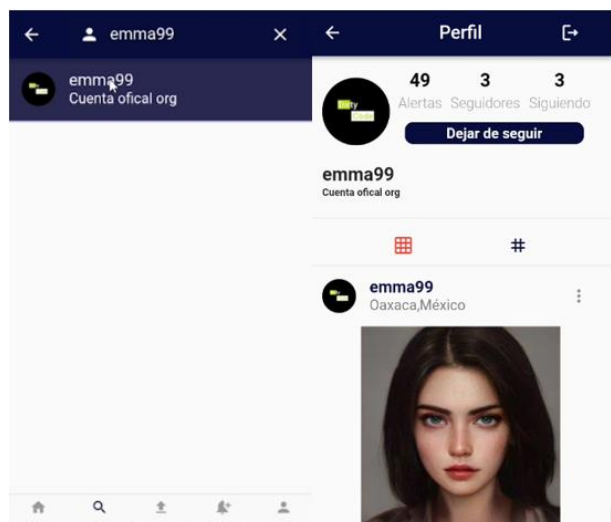


Figure 7 User search screen.

7. Create alert: In this interface when pressing the button Create Alert, it displays a menu to select the image, either by taking a picture with the camera or by the gallery, see figure 8.

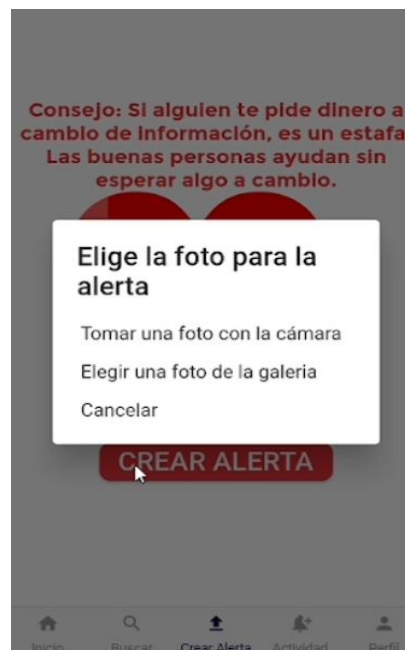


Figure 8 Screen for selecting a photo

8. Form to create an alert: in this screen the previously selected photo is shown, it also shows a form to fill in the respective data, the alert is published once the Upload button is pressed, as shown in the following figure.

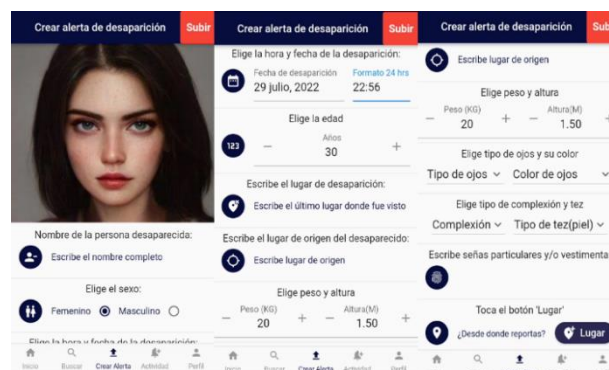


Figure 9 Form to create an alert

9. Notifications panel: This interface displays the notifications regarding our profile and our publications made. Notifications can be received when a user follows our account, if he/she reacts to the alert or comments on it. It also allows navigation, see the following figure.

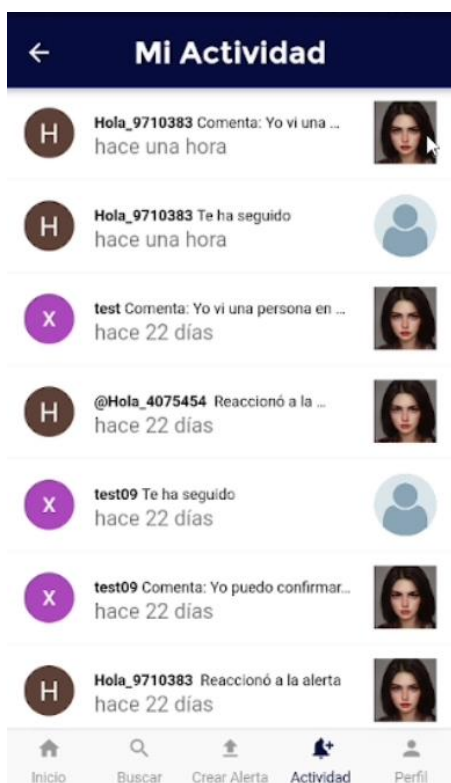


Figure 10 Notifications panel screen

10. Sharing option: In this interface, when you click on the share button on an alert, the mobile application takes you to the messaging application that you have on your mobile device, and you can share the alert data such as: photograph, name, age and place of disappearance, as shown in figure 11.

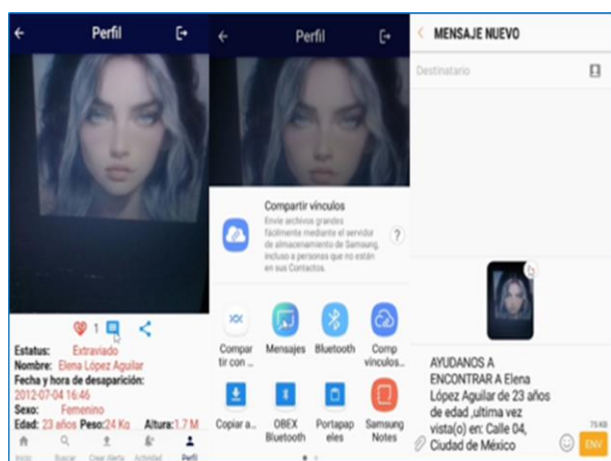


Figure 11 Sharing option

11. Prohibit screenshot. This interface shows when a user wants to take a screenshot of the photograph of the missing person, the application displays a message, as it is configured to block this process, see figure 12.



Figure 12 Prohibit screenshots

## Acknowledgements

To the Tecnológico Nacional de México/Instituto Tecnológico de Oaxaca for the facilities and space for the development of this research work. We are grateful for the collaboration and dedication of the authors of the article who participated responsibly in the research until the results presented here were achieved; the aim of this research is to be able to disseminate the findings to the academic community and the general public about the work being carried out at the Institution.

## Conclusions

Mobile applications today enable access to a growing diversity of tools and services that facilitate productive activities. Mobile applications are here to stay, their continuous growth will continue to impact our lifestyle and the way we carry out our activities. The Mobile Application: Social network for the search of missing persons, is a native application with altruistic purposes to help find missing persons and to prevent the most common cybercrimes, creating a community through the format of a social network for the issuance of publications and alerts to the serious social problem of insecurity that we are living day by day in which today faces society in our country.

**References**

ADNPolítico. (2021, August 7). ADNPolítico. <https://politica.expansion.mx/mexico/2021/08/06/voces-los-desaparecidos-es-la-otra-pandemia-que-azota-a-mexico>

Ambler, S., 1995. Using Use-Cases, Software Development, pp. 53-61.

Cohn (2004). User Stories Applied for Agile Software Development. Boston: Pearson Education, Inc.

Hernández, S. R. (2020). Mecanismos extrainstitucionales para la búsqueda de personas desaparecidas en México. *Pluralidad y Consenso*, 9(42), 88-107.

Hernández, R., Fernández, C., y Baptista, P. (2006). Metodología de la investigación, cuarta edición, editorial Mc Graw Hill, 2006. Iztapalapa, México DF.

Pressman, R., S. (2010). Ingeniería de Software. un enfoque práctico McGraw Hill Education.

Zoiner Tejada, (2018). Non-relational data and NoSQL. <https://docs.microsoft.com/enus/azure/architecture/data-guide/big-data/non-relational-data>.

## Mobile application to traceability of corn production in the Valle del Mezquital

### Aplicación móvil para la trazabilidad de la producción de maíz en el Valle del Mezquital

PEREZ-BAUTISTA, Mario†\*, NAVARRETE-ARIAS, Dulce Jazmín and HERNANDEZ-GARCIA, Héctor Daniel

*Tecnológico Nacional de México, Instituto Tecnológico Superior del Occidente del Estado de Hidalgo, División de Ingeniería en Sistemas Computacionales. México.*

ID 1<sup>st</sup> Author: Mario, Pérez-Bautista / **ORC ID:** 0000-0002-3260-906X, **CVU CONACYT ID:** 638669

ID 1<sup>st</sup> Co-author: Dulce J., Navarrete-Arias / **ORC ID:** 0000-0002-7915-068X, **Researcher ID Thomson:** AAR-8785-2021, **CVU CONACYT ID:** 366071

ID 2<sup>nd</sup> Co-author: Héctor Daniel, Hernández-García / **ORC ID:** 0000-0001-5261-8353, **CVU CONACYT ID:** 208146

**DOI:** 10.35429/JCA.2022.19.6.23.29

Received July 30, 2022; Accepted December 30, 2022

#### Abstract

This work presents the development in Android Studio of three mobile applications and a web service in php that allows the agronomists of Centro de innovación y Desarrollo Tecnológico del Valle del Mezquital (CiDT) to manage the traceability logs of corn production in the field. from the preparation of the soil, sowing, irrigation, applications to the harvest, and that this serves so that the final consumers know the process of the product that they acquire only by scanning the QR code printed on the sack. In this way, the CiDT seeks to give added value to the production of the farmers of the Valle del Mezquital, offering food certainty to its buyers. The scrum methodology was used to organize the user stories, the client server architecture was implemented to establish communication between the database and the mobile devices, after the development an empirical evaluation of usability was applied with the Agronomist in charge to identify his point of view about the ease of use, security, error rate, satisfaction and graphical interface, with 70 points in his perception of usability.

#### Android, Corn, Traceability

#### Resumen

Este trabajo presenta el desarrollo en Android Studio de tres aplicaciones móviles y un web service en php que permita a los técnicos agrónomos del Centro de innovación y Desarrollo Tecnológico del Valle del Mezquital (CiDT) gestionar las bitácoras de trazabilidad de la producción de Maíz en campo desde la preparación del suelo, siembra, riegos, aplicaciones hasta la cosecha, y que esta sirva para que los consumidores finales conozcan el proceso del producto que adquieren unicamente escaneando el código QR impreso en el costal. De esta forma el CiDT busca dar valor agregado a la producción de los campesinos del Valle del Mezquital ofreciendo certidumbre alimentaria a sus compradores. La metodología scrum se usó para organizar las historias de usuario, la arquitectura cliente servidor se implementó para establecer la comunicación entre la base de datos y los dispositivos móviles, después del desarrollo se aplicó una evaluación empírica de usabilidad con la técnico Agrónomo a cargo para identificar su punto de vista acerca de la facilidad de uso, seguridad, tasa de errores, satisfacción e interfaz gráfica, con 70 puntos en su percepción de usabilidad.

#### Android, Maíz, Trazabilidad

**Citation:** PEREZ-BAUTISTA, Mario, NAVARRETE-ARIAS, Dulce Jazmín and HERNANDEZ-GARCIA, Héctor Daniel. Mobile application to traceability of corn production in the Valle del Mezquital. *Journal Applied Computing*. 2022. 6-19:23-29.

\* Correspondence to the Author (E-mail: mperez@itsoeh.edu.mx)

† Researcher contributing as first author.

## Introduction

Product traceability describes the processes and techniques used to know the location and trajectory of a batch of products along its supply chain, and now with the support of technology, consumer participation is emphasised (Moltoni and Moltoni, 2015). The importance of having it in the agri-food industry is to guarantee the quality and safety of product consumption, in addition to the regulatory requirements imposed by European governments after poisonings or the appearance of diseases such as mad cow disease and Genetically Modified Organisms (GMOs) (Fernandez Andrade, 2012).

Maize production in Mexico has a cultural, social and economic importance, especially white maize destined for human consumption and represents 86.94% of annual production the rest of yellow maize is destined to industry in smaller percentage, but despite its relevance the country still imports to the United States, Argentina, Brazil and Canada to meet its consumption need, the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA) has established strategies to maintain production to ensure its supply (SAGARPA, 2017).

In addition, the secretariat and producers in the region have established five demands in plenary meetings to boost maize production, including the Demand for new knowledge, Demand for Training, Demand for the creation of new technology, Demand for public policy and Demand for Technology Transfer (Moctezuma-López et al., 2010).

This paper explains the development of the mobile application that the Centre for Innovation and Technological Development (CiDT) needs to implement with the producers of the Mezquital Valley. As a first point, the background of web or mobile development projects that have been used in similar contexts is analysed, to then describe the problem that the CiDT raises, highlighting the benefits of its construction, followed by the development process and ending with the implementation and evaluation of usability.

Currently, the International Maize and Wheat Improvement Centre (CIMMYT) uses a web-based maize and wheat production traceability system called BEM or Bitácora Electrónica, which is operated by the regional research centres in the country through SEDAGRO, the Secretariat of Agricultural Development, and keeps records of the maize and wheat production process of the producers who are advised by the centres.

Meza-Leal describes a mobile system in which each producer in the state of Colima Mexico will be able to register all his processes for the traceability of coffee within a database that will have an interface within a mobile device accessing an internet connection. This interface will have two modules, one for registration and consultation of the processes of coffee traceability and the production module in which the type of nutrition that the coffee plant has, the record of pests, diseases, harvest, periods, the number of cuts that are made to the coffee farm of each producer and the record of the sale in kilos are registered. (Meza-Leal et al., 2017).

The León-Duarte study produced a methodology to improve a harness production process through the implementation of an electronic monitoring system using barcode and RFID technology, thereby also seeking faster data capture, reducing errors and cost, reducing paperwork and better measuring productivity, and will be applied in the foam injection process, which is the area where the company has spent about 80% of the budget due to errors and this system seeks to know the products entering and leaving the area, the efficiency per mould and defects per station, among other benefits (León-Duarte et al., 2020).

The CIDT is a body of the Secretariat of Agricultural Development of the State of Hidalgo and carries out research, validation, training and technology transfer for small producers in the Mezquital Valley region. It is located in the municipality of Mixquiahuala de Juárez Hidalgo and has 4.5 hectares of experimental crops. The results of their research are applied to improve the productivity, profitability and sustainability of the production systems demanded in the region.



Jaime Bernal Ortega, the head of the research centre, considers it vital to make it known that maize production in the region uses sustainable techniques with a minimum use of chemicals and a good selection of seeds that improve crop yields. And that companies such as Minsa and Bimbo, who buy a percentage of the harvest, continue to maintain their standards as socially responsible companies, making known the details with which the product they purchase was generated.

The electronic traceability project aims to add value to the production of white maize (*Zea mays* L. Gramineae) and yellow maize from producers in the Mezquital Valley, allowing buyers to know the details of sowing, irrigation, type of substances applied in the fertilisation and pest elimination processes, guaranteeing the origin and production process. The guarantee of origin generates confidence in the buyer by knowing the technical details that were used and that will also be offered later when it has been transformed into derivatives for sale.

The Mezquital Valley contributes 59% of the Gross Domestic Product of the state of Hidalgo, its main activity is agriculture and livestock farming, with a cultivated area of 61,512. 45 hectares, with green alfalfa and corn being the main products it generates and the ones that contribute the most economic value. It is worth mentioning that the region has benefited from irrigation with wastewater from the Valley of Mexico, which has increased the production of the region's arid soil; the importance of corn production is vital if we consider that the state and the region have high levels of marginalisation (García-Salazar, 2019).

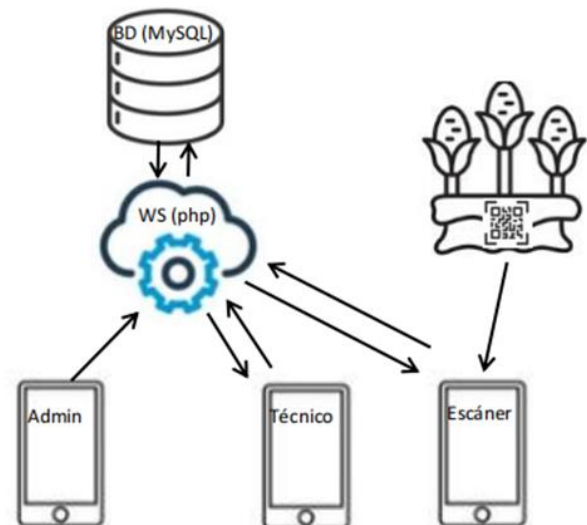
**Methodology**

The main function of the mobile application that was developed is to record in an electronic logbook the traceability of the production system of the producers' maize plots managed by the CiDT. The Scrum methodology was used to organise the requirements in user stories and distribute the development times, after the initial interview, it was summarised in the stories shown in table 1.

ID	Description	Validation
HU01	As: Technician Desire: Manage logbooks for each plot. To: Manage crop traceability.	Add, display and edit logs
HU02	As: Technician Desire: Manage plots To: have plots for each logbook.	Add, display and edit parcels
HU03	As: Technician Wants: Manage producers For: have producer for each plot.	Adds, displays and edits producers
HU04	As: Technician Wants: Generate QR code of completed logs. To: print and add to harvest sack.	Generates a QR code for each completed logbook.
HU05	As: Technician I want: to have secure information for each logbook. To: only me to manage logs, plots and producers under my care.	Verifies that the user and password are registered in the database.
HU06	As: Technician I want to: Scan the QR code To: verify the information that will be shown to the consumer.	Captures a QR code with the scanner and displays the logbook.
HU07	As: Consumer I want: Scan the QR code To: check the traceability of each bag of maize.	Captures a QR code with the scanner and displays the log.
HU08	As: Administrator Wish: Manage technicians To: control the people in charge of each plot.	Adds, displays and edits technicians.

**Table 1** User stories  
*Source: Own elaboration*

To solve the needs, an app was developed for each user connected to a single database through a web service in php that handles the requests of three mobile applications developed in Android Studio, as shown in Figure 1.



**Figure 1** Implementation diagram  
*Source: Own elaboration*

The administrator app registers the agronomists and the technician app manages the logbooks which keeps records of producers, plots, sowings, applications, irrigations, soil preparation processes, and harvesting, through a database managed in the cloud and at the same time, Another mobile application allows buyers to access the detailed report of the product they purchase by scanning the QR code printed on the bags of the final product, showing all the information that the technicians recorded, thus giving added value to the maize produced in the Mezquital Valley, offering certainty of the type of maize and its entire production process.

The CiDT technicians are the ones who keep track of the plots of each producer in each agricultural cycle, and the QR code reader will be the application for the companies that purchase maize from the producers of the Mezquital Valley and manages the CiDT.

- The agronomists are responsible for managing (registering, deregistering and modifying) producers, plots and sowings.
- The agronomists register the logbooks associating the plot and the producer, recording gradually as irrigation and applications evolve from soil treatment to harvest, which is the moment when the QR code is generated, which the producers can print on the sacks of the final product.
- When registering the data of the plot, the georeference data is also registered, to identify its physical location, which was a specific requirement of the technicians.

Usability is an intangible quality that consists of a series of characteristics that a software product must have to ensure that it will be adopted by users, there are empirical and heuristic methods for evaluation, some evaluation proposals are the ISO 25010 Standard (Mex-Alvarez et al., 2019).

The evaluation of the final product was carried out using the empirical proposal of Mascheroni et al., who apply a series of questions to the end user about ease of use, security, error rate, satisfaction and adequate graphical interface, assign weights and make an estimate of the percentage of usability (Mascheroni,2012).

### Results

The relational database in Figure 2 shows that the logbook table is managed by a single technician and this in turn relates to several jobs, sowings, applications, irrigations and harvests for a single plot, and that a farmer can have more than one plot.

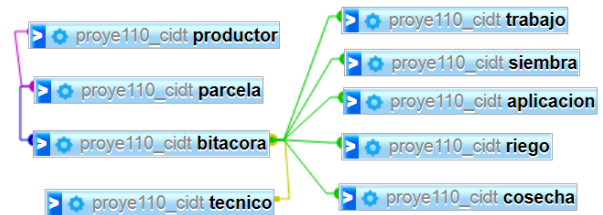


Figure 2 Database diagram  
Source: Own elaboration

The development of the application was done in Android Studio for SDK 29 with minimal16 and the use of the google maps API for the location of the plots.

The administrator app shows the list of agronomists with a search box for when the list is larger than one screen, Figure 3 shows a view of the list. For each technician in the list, the name, email and the total number of logs he/she manages are displayed, the figure shows the list view with a floating add button with a plus symbol.

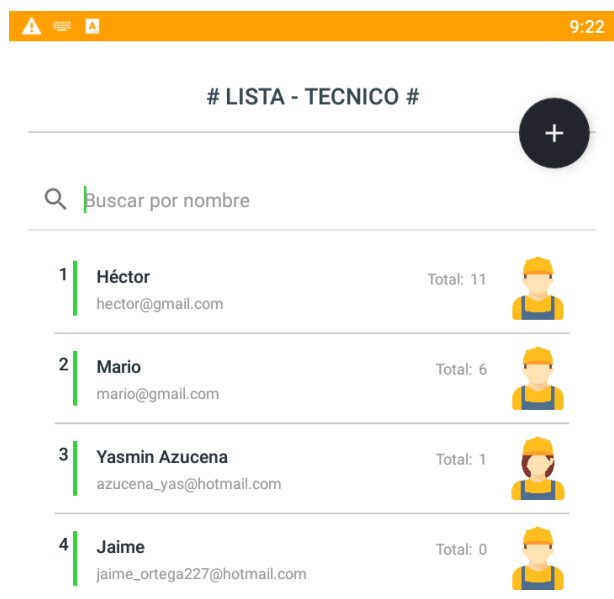


Figure 3 Technician list view  
Source: Own elaboration

When an item is selected from the list of technicians, the general data of the technician and the list of logs that he/she manages will be shown, if it is completed, it will be shown with a QR icon, the floating button with a pencil allows editing the technician's data, such as changing the password, gender or name, A list of logs is shown in Figure 4.

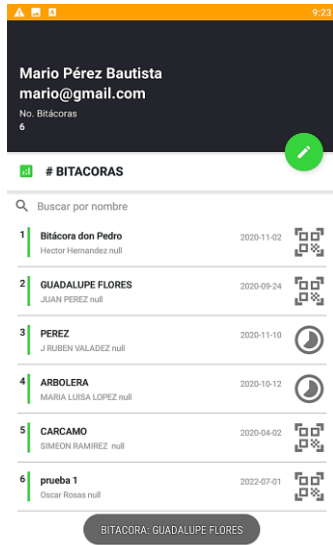


Figure 4 Log list view by technician  
Source: Own elaboration

Users of the agronomist application must authenticate themselves to enter the main menu where they can register new producers, plots and logs, as well as scan QR codes, Figure 5 shows the login and Figure 6 the main menu.

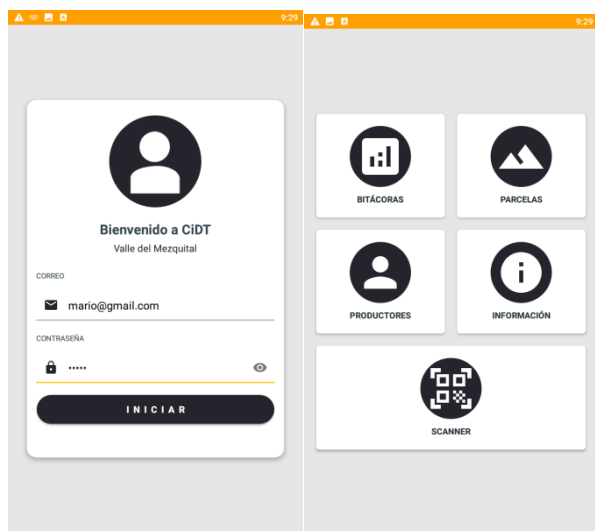


Figure 5-6 Login view and main menu of the technical app  
Source: Own elaboration

Figure 7 shows that when the logbook option is selected, it will list those in charge with the option to add new ones, when choosing one of them you can see the general data with the options to edit, add data on planting, work, applications, irrigation and harvest, the status can be completed or in process, while it is in process you can not consult its QR code.

As an example, Figure 8 shows the view for editing applications, but each option in the logbook menu has a view depending on the information required.

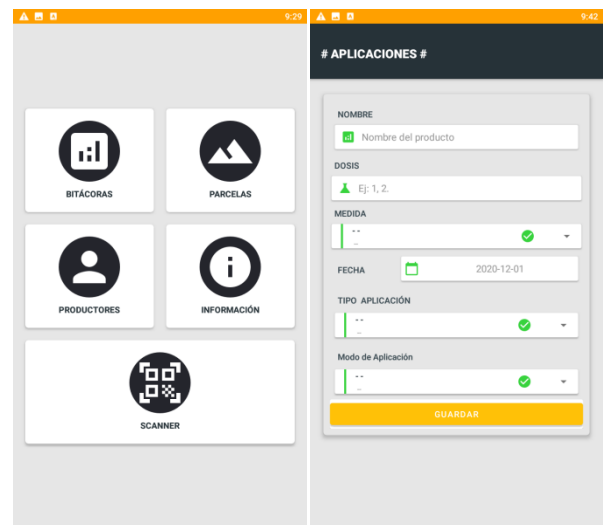


Figure 7-8 Logbook menu and application editing view  
Source: Own elaboration

The scanner app turns on the camera looking for a QR code, if it finds a match it displays the log data associated with the code. Figure 9 shows an example of a QR code from a completed log, and Figure 10 shows the information displayed by the scanner app after reading the QR code.

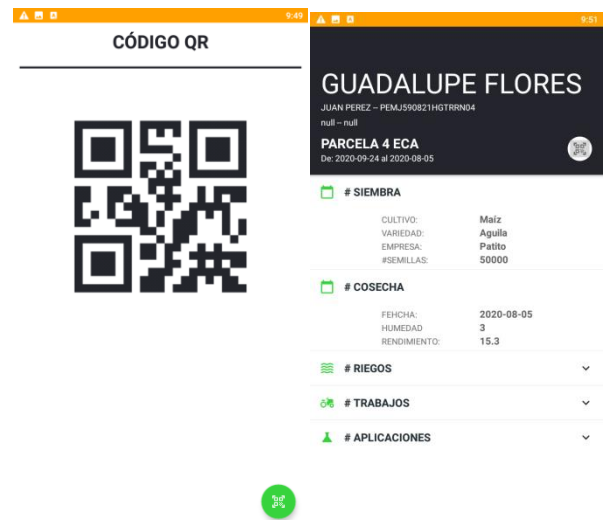


Figure 9-10 QR code view and query in the scanner app  
Source: Own elaboration

In this way, whoever has the scanner application and wants to know the traceability of the product associated with the QR code only has to point the scanner and the app will show a view with the details of the producer, plot, sowing, harvest, irrigation, work and applications, offering certainty of the process that took the maize acquired from the preparation of the soil to the harvest.

Finally, the usability evaluation was carried out by applying the series of questions to the CiDT technical manager, applying the weights per sub-attribute according to the answers she assigned, and the results were summarised in table 2.

Attribute	Question	P	V
Ease of use	Did you find the application easy to use?	30	65
	Did you require assistance to perform the requested tasks?	-7.5	
	Do you consider the application easy to use for anyone with the ability to operate a computer or system?	40	
	Do you consider that no prior knowledge is required to be able to perform the requested tasks?	20	
	Does the application have messages or instructions that are not clear in order to carry out a task?	-15	
	Do you consider that the application has a number of unnecessary steps to carry out each task?	-2.5	
Security	Do you consider the application reliable?	50	80
	Do you consider the application secure, in terms of privacy?	30	
Error rate	Did you make one/many mistake(s) while performing the task(s), due to not clearly reading a message or prompt from the application?	22.5	25
	Did you make one/many mistake(s) while performing the task(s) because a message(s) or prompt(s) on the application was unclear?	22.5	
Satisfaction	If you had the opportunity, would you use the app more often?	50	100
	Were you comfortable with using the app?	50	
Graphical interface adequate	Did you find the app stylish or attractive (appropriate colour scheme, legible font sizes, etc.)?	80	80

**Table 2** Usability evaluation  
*Source: Own elaboration*

**Conclusions**

Table 2 classifies the attributes that had been proposed to evaluate, the question values in points (column P) each sub-attribute and the sum of the attribute is represented in column V, in this way, it is concluded that 65 points are assigned to the ease of use considering that in the evaluation if you had to give assistance because the level of expertise shown by the agricultural technician is medium, she interacts regularly with other applications but because it was the first time with the traceability app if she asked questions.

She assigned 80 points to security because the administrator app does not have a login, it was clarified that in future works the management of technicians and logs can be done more comfortably from a web version, 25 points to the error rate because of connectivity failures on the day of delivery and evaluation the map did not load and due to signal latency she pressed three times to create a job to a plot because it took time for the server to respond. The satisfaction was given 100 points because he considers that it is more practical to register the data of the plots from the mobile phone because he did it from a sheet and had to concentrate manually each logbook in the office, finally for the graphical interface he assigned 80 points, giving on average the accumulated of the sub attributes in 70 points of usability.

The end user's perception is acceptable but future work is expected to add deletion and reporting functionalities from a web version to improve the comfort when managing plots, producers and logs, The main objective was achieved because the technician version will allow the agronomist to register the events that happen to the product in the field and the final consumer will be able to know these details with the scanner version by pointing to the sacks with the printed QR code. With the two main applications, the traceability of maize production in the Mezquital Valley controlled by the CiDT can now be managed and made known.

**Acknowledgement**

We are grateful for the contribution of Engineer Jaime Ortega Bernal, in charge of the Centre for Innovation and Technological Development of the Mezquital Valley, a dependency of SEDAGRO, as well as Engineer Yasmin Azucena Mayorga for her advice and contribution to the evaluation. To the Instituto Tecnológico Superior del Occidental del Estado de Hidalgo for its support with the contribution of laboratories and research and development hours, and to Ing. Héctor Hernández Estrada for his technical and development support.

**Funding**

Funding: This work has been funded by TecNM [project registration 10260.21-PD].

**References**

- Fernández Andrade, R. (2012). Trazabilidad alimentaria Una herramienta decisiva para la seguridad y la protección de los consumidores. *Distribución y consumo*, 12, 5-10. [https://www.mapa.gob.es/ministerio/pags/biblioteca/revistas/pdf\\_DYC/DYC\\_2002\\_62\\_5\\_9.pdf](https://www.mapa.gob.es/ministerio/pags/biblioteca/revistas/pdf_DYC/DYC_2002_62_5_9.pdf)
- García-Salazar, E. M. (2019). El agua residual como generadora del espacio de la actividad agrícola en el Valle del Mezquital, Hidalgo, México. *Estudios Sociales. Revista de Alimentación Contemporánea y Desarrollo Regional*. <https://doi.org/10.24836/es.v29i54.741>
- León-Duarte, J. A., Re-Iñiguez, B. M. D. L., & Romero-Dessens, L. F. (2020). Ventajas del uso de sistemas de trazabilidad electrónica en procesos de manufactura. *Información tecnológica*, 31(1), 237-244. <https://doi.org/10.4067/S0718-07642020000100237>
- Mascheroni, M., Greiner, C., Dapozo, G., & Estayno, M. (2012, octubre). Herramienta para automatizar la evaluación de la usabilidad en productos software. XVIII Congreso Argentino de Ciencias de la Computación. <http://sedici.unlp.edu.ar/handle/10915/23732>
- Mex-Alvarez, D. C., Hernández-Cruz, L. M., Uc-Rios, C. E., & Cab-Chan, J. R. (2019). Análisis de usabilidad web a través de métricas estandarizadas y su aplicación práctica en la plataforma SAEFI. *ECORFAN*, 3(9), 15-24. <https://doi.org/10.35429/JOCT.2019.9.3.15.24>
- Meza-Leal, J., Farías-mendoza, N., & Chavez-Valdez, R. (2017). Trazabilidad de la Producción y Cosecha del Café Orgánico implementado con Tecnologías Móviles—RIIT. *Revista Internacional de Investigación e Innovación Tecnológica*, 5(27), 1-17. [https://riit.com.mx/apps/site/files/trazabilidad\\_del\\_caf\\_resultados\\_idt\\_2.pdf](https://riit.com.mx/apps/site/files/trazabilidad_del_caf_resultados_idt_2.pdf)
- Moctezuma-López, G., Espinosa-García, J. A., Cuevas-Reyes, V., Jolalpa-Barrera, J. L., & Vélez-Izquierdo, A. (2010). Innovación tecnológica de la cadena agroalimentaria de maíz para mejorar su competitividad: Estudio de caso en el estado de Hidalgo. *Revista Mexicana de Ciencias Agrícolas*, 1(1), 101-110. <https://www.redalyc.org/articulo.oa?id=263120585011>
- Moltoni, L. A., & Moltoni, A. F. (2015). Trazabilidad: El rol de la información en el marco del nuevo paradigma de la calidad. *Agroalimentaria*, 21(40), 79-96. <https://www.redalyc.org/pdf/1992/199241170005.pdf>
- SAGARPA. (2017). Maíz grano blanco y amarillo mexicano. *Planeación Agrícola Nacional 2017-2030*, 1(1-20). [https://www.gob.mx/cms/uploads/attachment/file/256429/B\\_sico-Ma\\_z\\_Grano\\_Blanco\\_y\\_Amarillo.pdf](https://www.gob.mx/cms/uploads/attachment/file/256429/B_sico-Ma_z_Grano_Blanco_y_Amarillo.pdf)

---

## **Instructions for Scientific, Technological and Innovation Publication**

---

### **[Title in Times New Roman and Bold No. 14 in English and Spanish]**

Surname (IN UPPERCASE), Name 1<sup>st</sup> Author†\*, Surname (IN UPPERCASE), Name 1<sup>st</sup> Co-author, Surname (IN UPPERCASE), Name 2<sup>nd</sup> Co-author and Surname (IN UPPERCASE), Name 3<sup>rd</sup> Co-author

*Institutional Affiliation of Author including Dependency (No.10 Times New Roman and Italic)*

ID 1<sup>st</sup> author: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 1<sup>st</sup> author: (Scholar-PNPC or SNI-CONACYT) (No.10 Times New Roman)

ID 1<sup>st</sup> co-author: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 1<sup>st</sup> co-author: (Scholar or SNI) (No.10 Times New Roman)

ID 2<sup>nd</sup> co-author: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 2<sup>nd</sup> co-author: (Scholar or SNI) (No.10 Times New Roman)

ID 3<sup>rd</sup> co-author: (ORC ID - Researcher ID Thomson, arXiv Author ID - PubMed Author ID - Open ID) and CVU 3<sup>rd</sup> co-author: (Scholar or SNI) (No.10 Times New Roman)

(Report Submission Date: Month, Day, and Year); Accepted (Insert date of Acceptance: Use Only ECORFAN)

---

#### **Abstract (In English, 150-200 words)**

Objectives  
Methodology  
Contribution

#### **Keywords (In English)**

Indicate 3 keywords in Times New Roman and Bold No. 10

#### **Abstract (In Spanish, 150-200 words)**

Objectives  
Methodology  
Contribution

#### **Keywords (In Spanish)**

Indicate 3 keywords in Times New Roman and Bold No. 10

---

**Citation:** Surname (IN UPPERCASE), Name 1<sup>st</sup> Author, Surname (IN UPPERCASE), Name 1<sup>st</sup> Co-author, Surname (IN UPPERCASE), Name 2<sup>nd</sup> Co-author and Surname (IN UPPERCASE), Name 3<sup>rd</sup> Co-author. Paper Title. Journal of Applied Computing Year 1-1: 1-11 [Times New Roman No.10].

---

---

\* Correspondence to Author (example@example.org)

† Researcher contributing as first author.

# Instructions for Scientific, Technological and Innovation Publication

## Introduction

Text in Times New Roman No.12, single space.

General explanation of the subject and explain why it is important.

What is your added value with respect to other techniques?

Clearly focus each of its features

Clearly explain the problem to be solved and the central hypothesis.

Explanation of sections Article.

## Development of headings and subheadings of the article with subsequent numbers

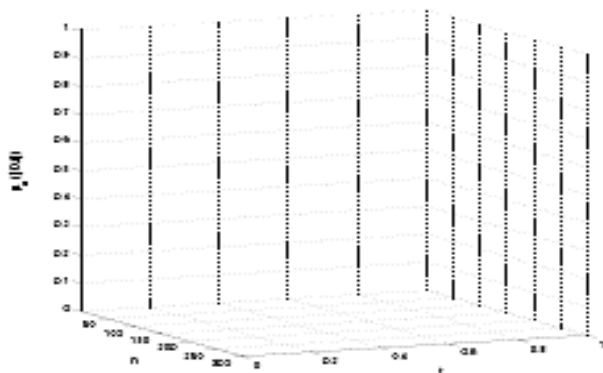
[Title No.12 in Times New Roman, single spaced and bold]

Products in development No.12 Times New Roman, single spaced.

## Including graphs, figures and tables-Editable

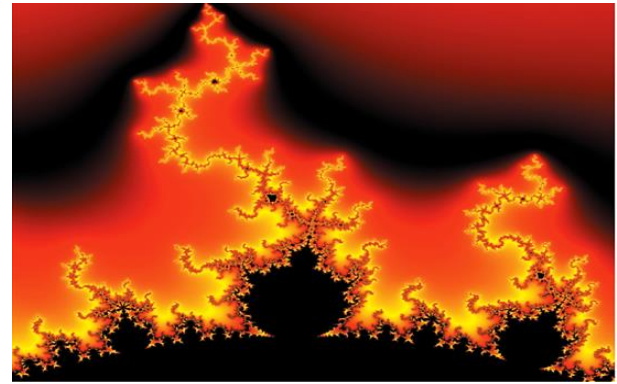
In the article content any graphic, table and figure should be editable formats that can change size, type and number of letter, for the purposes of edition, these must be high quality, not pixelated and should be noticeable even reducing image scale.

[Indicating the title at the bottom with No.10 and Times New Roman Bold]



**Graphic 1** Title and Source (in italics)

Should not be images-everything must be editable.



**Figure 1** Title and Source (in italics)

Should not be images-everything must be editable.

Table 1				

**Table 1** Title and Source (in italics)

Should not be images-everything must be editable.

Each article shall present separately in **3 folders**:  
a) Figures, b) Charts and c) Tables in .JPG format, indicating the number and sequential Bold Title.

## For the use of equations, noted as follows:

$$Y_{ij} = \alpha + \sum_{h=1}^r \beta_h X_{hij} + u_j + e_{ij} \quad (1)$$

Must be editable and number aligned on the right side.

## Methodology

Develop give the meaning of the variables in linear writing and important is the comparison of the used criteria.

## Results

The results shall be by section of the article.

## Annexes

Tables and adequate sources thanks to indicate if were funded by any institution, University or company.

## Conclusions

Explain clearly the results and possibilities of improvement.

# **Instructions for Scientific, Technological and Innovation Publication**

## **References**

Use APA system. Should not be numbered, nor with bullets, however if necessary numbering will be because reference or mention is made somewhere in the Article.

Use Roman Alphabet, all references you have used must be in the Roman Alphabet, even if you have quoted an Article, book in any of the official languages of the United Nations (English, French, German, Chinese, Russian, Portuguese, Italian, Spanish, Arabic), you must write the reference in Roman script and not in any of the official languages.

## **Technical Specifications**

Each article must submit your dates into a Word document (.docx):

Journal Name

Article title

Abstract

Keywords

Article sections, for example:

1. *Introduction*
2. *Description of the method*
3. *Analysis from the regression demand curve*
4. *Results*
5. *Thanks*
6. *Conclusions*
7. *References*

Author Name (s)

Email Correspondence to Author

References

## **Intellectual Property Requirements for editing:**

- Authentic Signature in Color of Originality Format Author and Co-authors.
- Authentic Signature in Color of the Acceptance Format of Author and Co-authors.
- Authentic Signature in blue colour of the Conflict of Interest Format of Author and Co-authors.



## **Reservation to Editorial Policy**

Journal of Applied Computing reserves the right to make editorial changes required to adapt the Articles to the Editorial Policy of the Journal. Once the Article is accepted in its final version, the Journal will send the author the proofs for review. ECORFAN® will only accept the correction of errata and errors or omissions arising from the editing process of the Journal, reserving in full the copyrights and content dissemination. No deletions, substitutions or additions that alter the formation of the Article will be accepted.

## **Code of Ethics - Good Practices and Declaration of Solution to Editorial Conflicts**

### **Declaration of Originality and unpublished character of the Article, of Authors, on the obtaining of data and interpretation of results, Acknowledgments, Conflict of interests, Assignment of rights and Distribution**

The ECORFAN-Mexico, S.C Management claims to Authors of Articles that its content must be original, unpublished and of Scientific, Technological and Innovation content to be submitted for evaluation.

The Authors signing the Article must be the same that have contributed to its conception, realization and development, as well as obtaining the data, interpreting the results, drafting and reviewing it. The Corresponding Author of the proposed Article will request the form that follows.

Article title:

- The sending of an Article to Journal of Applied Computing emanates the commitment of the author not to submit it simultaneously to the consideration of other series publications for it must complement the Format of Originality for its Article, unless it is rejected by the Arbitration Committee, it may be withdrawn.
- None of the data presented in this article has been plagiarized or invented. The original data are clearly distinguished from those already published. And it is known of the test in PLAGSCAN if a level of plagiarism is detected Positive will not proceed to arbitrate.
- References are cited on which the information contained in the Article is based, as well as theories and data from other previously published Articles.
- The authors sign the Format of Authorization for their Article to be disseminated by means that ECORFAN-Mexico, S.C. In its Holding Spain considers pertinent for disclosure and diffusion of its Article its Rights of Work.
- Consent has been obtained from those who have contributed unpublished data obtained through verbal or written communication, and such communication and Authorship are adequately identified.
- The Author and Co-Authors who sign this work have participated in its planning, design and execution, as well as in the interpretation of the results. They also critically reviewed the paper, approved its final version and agreed with its publication.
- No signature responsible for the work has been omitted and the criteria of Scientific Authorization are satisfied.
- The results of this Article have been interpreted objectively. Any results contrary to the point of view of those who sign are exposed and discussed in the Article.

## Copyright and Access

The publication of this Article supposes the transfer of the copyright to ECORFAN-Mexico, S.C. in its Holding Spain for its Journal of Applied Computing, which reserves the right to distribute on the Web the published version of the Article and the making available of the Article in This format supposes for its Authors the fulfilment of what is established in the Law of Science and Technology of the United Mexican States, regarding the obligation to allow access to the results of Scientific Research.

Article Title:

Name and Surnames of the Contact Author and the Co-authors	Signature
1.	
2.	
3.	
4.	

## Principles of Ethics and Declaration of Solution to Editorial Conflicts

### Editor Responsibilities

The Publisher undertakes to guarantee the confidentiality of the evaluation process, it may not disclose to the Arbitrators the identity of the Authors, nor may it reveal the identity of the Arbitrators at any time.

The Editor assumes the responsibility to properly inform the Author of the stage of the editorial process in which the text is sent, as well as the resolutions of Double-Blind Review.

The Editor should evaluate manuscripts and their intellectual content without distinction of race, gender, sexual orientation, religious beliefs, ethnicity, nationality, or the political philosophy of the Authors.

The Editor and his editing team of ECORFAN® Holdings will not disclose any information about Articles submitted to anyone other than the corresponding Author.

The Editor should make fair and impartial decisions and ensure a fair Double-Blind Review.

### Responsibilities of the Editorial Board

The description of the peer review processes is made known by the Editorial Board in order that the Authors know what the evaluation criteria are and will always be willing to justify any controversy in the evaluation process. In case of Plagiarism Detection to the Article the Committee notifies the Authors for Violation to the Right of Scientific, Technological and Innovation Authorization.

### Responsibilities of the Arbitration Committee

The Arbitrators undertake to notify about any unethical conduct by the Authors and to indicate all the information that may be reason to reject the publication of the Articles. In addition, they must undertake to keep confidential information related to the Articles they evaluate.

Any manuscript received for your arbitration must be treated as confidential, should not be displayed or discussed with other experts, except with the permission of the Editor.

The Arbitrators must be conducted objectively, any personal criticism of the Author is inappropriate.

The Arbitrators must express their points of view with clarity and with valid arguments that contribute to the Scientific, Technological and Innovation of the Author.

The Arbitrators should not evaluate manuscripts in which they have conflicts of interest and have been notified to the Editor before submitting the Article for Double-Blind Review.

## **Responsibilities of the Authors**

Authors must guarantee that their articles are the product of their original work and that the data has been obtained ethically.

Authors must ensure that they have not been previously published or that they are not considered in another serial publication.

Authors must strictly follow the rules for the publication of Defined Articles by the Editorial Board.

The authors have requested that the text in all its forms be an unethical editorial behavior and is unacceptable, consequently, any manuscript that incurs in plagiarism is eliminated and not considered for publication.

Authors should cite publications that have been influential in the nature of the Article submitted to arbitration.

## **Information services**

### **Indexation - Bases and Repositories**

LATINDEX (Scientific Journals of Latin America, Spain and Portugal)

EBSCO (Research Database - EBSCO Industries)

RESEARCH GATE (Germany)

GOOGLE SCHOLAR (Citation Indexes-Google)

MENDELEY (Bibliographic Reference Manager)

REDIB (Ibero-American Network of Innovation and Scientific Knowledge- CSIC)

HISPANA (Bibliographic Information and Guidance-Spain)

### **Publishing Services:**

Citation and Index Identification H

Management of Originality Format and Authorization

Testing Article with PLAGSCAN

Article Evaluation

Certificate of Double-Blind Review

Article Edition

Web layout

Indexing and Repository

Article Translation

Article Publication

Certificate of Article

Service Billing

### **Editorial Policy and Management**

38 Matacerquillas, CP-28411. Moralarzal –Madrid-España. Phones: +52 1 55 6159 2296, +52 1 55 1260 0355, +52 1 55 6034 9181; Email: [contact@ecorfan.org](mailto:contact@ecorfan.org) [www.ecorfan.org](http://www.ecorfan.org)

**ECORFAN®**

**Chief Editor**

VALDIVIA - ALTAMIRANO, William Fernando. PhD

**Executive Director**

RAMOS-ESCAMILLA, María. PhD

**Editorial Director**

PERALTA-CASTRO, Enrique. MsC

**Web Designer**

ESCAMILLA-BOUCHAN, Imelda. PhD

**Web Diagrammed**

LUNA-SOTO, Vladimir. PhD

**Editorial Assistant**

TREJO-RAMOS, Iván. BsC

**Philologist**

RAMOS-ARANCIBIA, Alejandra. BsC

**Advertising and Sponsorship**

(ECORFAN® Spain), sponsorships@ecorfan.org

**Site Licences**

03-2010-032610094200-01-For printed material ,03-2010-031613323600-01-For Electronic material,03-2010-032610105200-01-For Photographic material,03-2010-032610115700-14-For the facts Compilation,04-2010-031613323600-01-For its Web page,19502-For the Iberoamerican and Caribbean Indexation,20-281 HB9-For its indexation in Latin-American in Social Sciences and Humanities,671-For its indexing in Electronic Scientific Journals Spanish and Latin-America,7045008-For its divulgation and edition in the Ministry of Education and Culture-Spain,25409-For its repository in the Biblioteca Universitaria-Madrid,16258-For its indexing in the Dialnet,20589-For its indexing in the edited Journals in the countries of Iberian-America and the Caribbean, 15048-For the international registration of Congress and Colloquiums. financingprograms@ecorfan.org

**Management Offices**

38 Matacerquillas, CP-28411. Moralzarzal – Madrid-España. Phones: +52 1 55 6159 2296, +52 1 55 1260 0355, +52 1 55 6034 9181; Email: contact@ecorfan.org www.ecorfan.org.

# Journal of Applied Computing

“Development of busbar differential protection algorithm on PSCAD”

**SHIH, Meng Yen, LEZAMA-ZÁRRAGA, Francisco Román, CHAN-GONZALEZ, Jorge de Jesús and SALAZAR-UITZ, Ricardo Rubén**

*Universidad Autónoma de Campeche*

“WMS computer tool of the company "Comunicación Telefónica de Antequera””

**ALTAMIRANO-CABRERA, Marisol, BENITEZ-QUECHA, Claribel, TORAL-ENRIQUEZ, Fernando and JIMENEZ-HALLA, Johann Francisco**

*Instituto Tecnológico de Oaxaca*

“Mobile application: social network for the search for missing persons”

**RAFAEL-PÉREZ, Eva, MARTÍNEZ-CASTELLANOS, Francisco Emmanuel, MORALES-HERNÁNDEZ, Maricela and MINGÜER-ALLEC, Luz María**

*Instituto Tecnológico de Oaxaca*

“Mobile application to traceability of corn production in the Valle del Mezquital”

**PEREZ-BAUTISTA, Mario, NAVARRETE-ARIAS, Dulce Jazmín and HERNANDEZ-GARCIA, Héctor Daniel**

*Instituto Tecnológico Superior del Occidente del Estado de Hidalgo*

